Railway Mechanical Engineer

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One of the greatest handicaps under which many railroad shops are required to work is insufficient jigs and fixtures.

The Development of Jigs and Fixtures

In many respects, the output of the shop is controlled by the number of jigs it has available and to what extent they can be efficiently used. In past years the development of jigs depended largely upon the ingenuity of the shop man. This system of development has resulted in many strange and novel contrivances which, if collected for some museum, would make an interesting exhibit. The systematic study and development of jigs and fixtures which has been made in recent years by a number of railroads has been productive of excellent results. The need for such work, with the ultimate purpose of standardization, has been brought up a number of times in the editorial columns of the *Railway Mechanical Engineer*, because the results already achieved indicate that increased efficiency in shop production may be effected by the railroads and that the work is well worth the cost.

In the development of jigs and fixtures a great deal more could be accomplished by co-operating with the machine tool manufacturers. Many of the manufacturers of machine tools for railroad shops have made intensive studies of railroad shop requirements and after extensive experiments have made available for the users of their machines, jigs and fixtures designed to handle various kinds of work. These jigs usually cost less than 25 per cent of the price of the machine, yet in a majority of cases they will double production. As a rule the manufacturers are in a far better position to develop, design and build fixtures for the tools they make than the individual railroad shop. They have available information and data that has been collected over a long period of years and in the case of grinding and milling machines few railroad shops have any information upon which a thorough study, relative to the development of jigs and fixtures, can be based.

Railroad men familiar with the usual attitude of the unions in wage negotiations must have been mildly amused when they read in the daily press the correspondence between Warren S. Stone, of the Brotherhood of Locomotive Engineers, and John L. Lewis, the head of the United Mine Workers, over the refusal of Mr. Stone to pay union wages in the mines owned by members of the enginemen's brotherhood and the consequent shut-down of these mines. Mr. Stone avers that the mines cannot be operated at union wages in competition with non-union mines without entailing a loss to the stockholders, members of the enginemen's union, who own the mines. Mr. Lewis counters this with contention that this is a problem to be solved by the management of the mines, for which miners are not responsible, since they have no voice in it. This is a well-known obstruction, and one which has wrecked many a wage conference between union organizations and the managements of frankly capitalistic enterprises. Mr. Stone and his labor union followers are facing a capitalist's problem in a typical capitalistic way. The question is, now that Mr. Stone has recognized the validity of this viewpoint as it applies to his mines, will he also recognize it in negotiations which he enters as a union man, and will the officers of the other railway unions be inclined to agree with him? It is one thing to set up a high standard of what wages and working conditions should be and quite another to find the money with which to meet this standard. Mr. Lewis's idea that finding the money is essentially a managerial function is an old one which heretofore has been accepted almost as an axiom in trade union policy. Mr. Stone's position in this controversy should show the fallacy of the notion and make it clear to unionists everywhere that they must either do all in their power to aid management in making production remunerative or be willing to work for the wages that the management can pay. The only other alternative is that now in effect in the enginemen's coal mines—a total shut-down with no returns either for the workers or the owners.

Mr. Stone as a Capitalist

Much interest was aroused by the results of the apprentice competition which was held by the *Railway Mechanical Engineer* last year. A number of contributions, including those of the prize winners, were published in the early months of this year. Other articles, which we had decided to use and which contain constructive and thought-provoking suggestions, were temporarily laid aside during the summer months while we published the series of articles describing the methods and practices of the Santa Fe apprenticeship department. With this issue we resume the publication of those contributions to the apprentice competition which were awarded honorable mention.

Making Better Workmen

For some reason very few contributions were received in our apprentice competition from the young men in the boiler shop. We are particularly gratified, therefore, to present elsewhere in this issue a constructive discussion from one of the boilermaker apprentices of the Erie Railroad. At the risk of becoming tiresome, may we again reiterate the statement that if the railroads are to make the best progress in training apprentices, they must have an appreciation of the boys' viewpoint, in order to know how best to reach and inspire them to put forth their best efforts. Mr. Wylie has some excellent suggestions to this end, which are well worth consideration.

It is interesting to note, also, that Mr. Wylie has placed special emphasis upon the necessity for the technical training of apprentices. Mechanics in some of the countries in continental Europe have always been noted for the thoroughness of their training and their fitness as all-around workmen. One reason for this is not hard to find. On visiting a large shop in Russian Poland, the officers in charge apologized for the way in which the apprentices were being trained. In-

quiry indicated that much the same methods were being used in this particular shop as in the average American railway shop. This was because the shops and the community were comparatively new and schools for technical instruction had not yet been inaugurated by the community. The officer explained that under normal conditions the boys would be required to complete a certain amount of technical training in the schools before they would be allowed to learn the practical details of the trade in the shops. Some of the railroads in this country have awakened to the necessity for providing technical training in the school room, either on the company premises or through outside agencies, but in coordination with the practical shop training. Many of our railroads, however, have failed to give this matter proper consideration, and as a result the graduate apprentices, unless they have followed special courses of study as individuals, are not as thoroughly trained for their life work or as capable as they should be. A greater appreciation of the value of such training on the part of the railroads will prove a large factor in maintaining the interest of the apprentices.

The Foreman's Job—A Competition

There has been a vast amount of discussion in recent years concerning the fact that the foreman, because he deals directly with the workers, occupies a tremendously important position in a large organization. Frequently he is the only man in the official family with whom the workers come in contact and they appraise and judge the entire organization from the standpoint of their dealings with him. On the other hand, the foreman is frequently the only channel through which the men may be informed and educated as to the policies and desires of the management. As the organizations have grown in size and have become more and more complicated with resulting frequent misunderstandings between the managements and the men, the position of the foreman has become more and more important. Unfortunately this was not recognized to any great extent and too little attention was paid to cultivating the foreman and preparing him to meet the responsibilities of his position in a big way. The past two or three years have witnessed a great awakening in this respect and many railroads are adopting constructive measures to overcome this weakness and place proper emphasis upon the importance of the foreman's position.

The *Railway Mechanical Engineer* desires to promote a constructive discussion of this whole question and announces a competition in which a first prize of $50 and a second prize of $35 will be awarded for the two most constructive articles received at our office in New York on or before December 1, 1924, on the opportunities and responsibilities of the foreman. In other words, what are the opportunities of the foremen in the way of strengthening the organization and giving the best possible account of themselves? Just how are these opportunities to be measured? What are the responsibilities of a foreman in the railway mechanical department—not in the way of detail methods and practices, but in getting the largest and best service from the workers, not alone in the selfish interests of the company or of himself, but to the mutual advantage of all concerned—the public, the men, the management and the owners?

When this topic was discussed at one of our staff meetings, the opinion was expressed that a competition of this sort would bring out only a theoretical discussion which would fail to make a distinct impression upon our readers and would not serve any constructive purpose. In answer to this, it was pointed out that events which have taken place in the railway mechanical field during recent years have served to emphasize the absolute necessity of the foremen facing up to their jobs in a large way and with a real comprehension of their great opportunities and of the heavy responsibilities which rest upon them. It was suggested that many foremen have been studying this whole question critically and that they are in a position to contribute specific facts and human interest incidents to back up their ideas which will be extremely valuable and helpful to their associates in other departments or on other roads. It is with this thought in mind that we are inviting the foremen to help us develop and promote a constructive discussion of this whole question.

The Cost of Delays

Under normal operating conditions, there is probably no one factor upon which may be placed more responsibility for delays to equipment held in shops for repairs than a lack of material with which to complete the work. It is an element which to some extent enters into and tends to interrupt the otherwise smooth operation of practically every railroad repair shop. The shop superintendent could ask for no more nearly ideal condition than to have available an unlimited stock of materials at all times. Such a condition might also help to eliminate many of the difficulties by which the general storekeeper is beset, but to maintain an adequate stock without accumulating an excess stock is the storekeeper's big problem. Fortunately, the general storekeeper or purchasing agent is able to show just what he can save in dollars and cents by a reduction in material stocks, whereas, on the other hand, the shop superintendent is usually at a loss to know how he can show up the actual cost of delayed repairs which may be occasioned by not having material.

When there is a heavy demand for power and the shops are operating at full capacity, delays to equipment undergoing repairs represent an actual loss in dollars and cents which may be evaluated by taking into consideration the rental value of a locomotive or car, and the shop space, as well as the increased labor cost due to disruption of the repair schedule, but it is only under such conditions that the delay represents an actual loss. Certainly a delay charge against a locomotive being repaired before placing it in storage or a charge for shop space, which would not otherwise be used, could never be justified.

The installation of a shop cost control system followed by a thorough analysis of the data which would then be available, would undoubtedly point out to the shop superintendent some way in which figures may be compiled to show the management just what these delays cost at a time when they represent an actual loss and would enable it to determine whether or not one department was economizing at the expense of another. Under such conditions, a scheme of shop cost accounting, showing in dollars and cents just what it costs to have a locomotive or car held in shop awaiting material, might be worth while, but would it not be better to direct attention to the institution of methods that would prevent such an occurrence?

An editorial in the *Railway Mechanical Engineer* some time ago suggested the desirability of studying this situation with a view to striking a proper balance between the objectives of the mechanical and stores departments and creating a better mutual understanding of the problems of both departments. Subsequent comment served to bring out some more or less biased opinions. The outstanding feature of the discussion was the tendency of the representatives of each department to lay stress upon their own particular troubles without offering any constructive suggestions as to how the other department might help to eliminate them. Is it not, after all, merely a question of complete co-operation?

One general storekeeper made the statement that the best possible insurance against delays attributable to shortage of material is a strongly organized service of supply. The op-

portunities for a thoroughly efficient stores organization, however, do not lie entirely within the jurisdiction of the stores department. There are many ways in which the mechanical department may assist in increasing stores department efficiency and in doing so serve its own purposes. The stores department is not able to serve to the best advantage without the possession of complete and timely information as to the requirements of other departments, not only as to the quality and quantity of material wanted, but a knowledge as to the actual time it is wanted as well. This naturally leads to the question of how well organized the shop may be, particularly in respect to the ability to anticipate probable future requirements of material.

The scheduling of railroad shop work has attracted considerable attention in recent years and some remarkably efficient systems have been developed and put into successful operation. Primarily, scheduling systems have been introduced to facilitate shop output, but if the possibilities of utilizing the schedule as an indicator of future requirements have not been considered, then it has failed to serve its full purpose.

A well-organized repair shop in which scheduling methods are used should be able to anticipate its future requirements with sufficient accuracy to furnish complete information to the stores department far enough in advance so that the necessary material could be secured and be available when needed. Having been forewarned of an approaching demand, a well-organized stores department should have no incentive for not furnishing the necessary material to meet the schedule.

Sound Judgment is Essential

A gang of skilled mechanics is stationed at the locomotive terminal to inspect locomotives as they come on the inspection pit and report any defects. Furthermore, the engineman, at the end of his run, reports the defects some of which can only be determined when the locomotive is working. These reports are sent to the office of the enginehouse foreman for the specific purpose of directing him and his assistants as to what repairs should be made on the locomotive so that it may be again dispatched and complete its run without a breakdown. But do these reports always accomplish the purpose for which they are intended? It is not unusual for an engineman to report that his locomotive would not make steam due to the flues being stopped up, dirty front end, valves out of square, or the diaphragm pipe out of line. As a usual rule defects of this nature do not develop on a single trip; upon investigation, it will probably be found that they have been consistently reported by previous enginemen. The natural question is, why have they not been repaired? The answer is that the gang foreman who received the engineman's work report passed these defects as O.K. for service. Again, locomotives break down or lose time on the road due to hot main pins or driving boxes, air pumps failing to keep up the required pressure, dirty feed valves, rods pounding badly, or other defects of a similar nature, which are reported by the locomotive inspectors. It is not unusual to develop the fact that such defects have been passed as serviceable. When the gang foreman responsible is pressed for an explanation as to why he permitted such locomotives to be marked up for their runs he will defend himself by stating that he did not have the material to make the repairs; or he was short of power; or he did not have sufficient time; in a few cases he may admit that he thought that the locomotive would make another trip and that the fellow at the other end of the division would repair it. The trouble is that there is too much of the prevailing spirit of taking a chance and depending upon the other fellow to do his work. Again, frequently, the foreman is not able to exercise good judgment in deciding on what should be repaired and what should be passed as serviceable.

A good enginehouse gang foreman should know a locomotive and be able to use sound judgment in passing on work reports. If a locomotive is dispatched on a run, and due to existing defects, a breakdown occurs it will cost money, time, and often human life. There is nothing which will more quickly arouse the ire of the traveling public than to have the train lose time because of defective equipment. If it is a frequent occurrence the railroad soon gains a bad reputation. One of the ways to help overcome such a situation is to use great care and discretion in selecting men to fill positions of gang foremen in the engine house.

New Books

THE MODERN FOREMAN. *By Robert Grimshaw, M. E., 297 pages, 5¾ in. by 8½ in. Price $2.50. Published by the Gregg Publishing Company, New York.*

The object of this book is to show the important part the foreman plays in increasing the efficiency of modern industrial plants. A comparison is given between the foreman of the past and present and his responsibilities to his employer, the workers and himself. Three chapters are devoted to men in the ranks and problems pertaining to them which the foreman must fundamentally understand. This is followed by an interesting discussion of the art of handling men with the object in view of obtaining the largest amount of production per man and still keep them contented and interested in their work.

Considerable space is given to the duties of the foreman. This includes a detailed discussion of the best methods of performing the various duties which confront the foreman during his daily routine. Considerable discussion has taken place in recent years as to the amount of clerical duties the foreman should have burdened upon him. The author, in a clear and concise manner, discusses the amount and best methods of performing this duty. In chapters nine and ten, it is pointed out that the foreman should aim to eliminate waste and also should study the most modern factory methods. These factors should be thoroughly understood in order that a foreman may function properly.

What the foreman should have and what he should know is covered in the two largest and most interesting chapters in the book. The importance of his mental training, his physique, his character, his personality, his imagination, his loyalty, etc., are interestingly discussed in these chapters. It is further pointed out that the foreman should have a general knowledge of human nature, of psychology, of teamwork, of management, etc., in order to successfully perform his duties and to prepare himself for further advancement.

The last 14 chapters deal with after thoughts which came to the author's mind during the sale of the first edition of this book. These chapters dwell on the foreman personally and discuss the peculiarities of various types of foremen. The book is written in a very interesting and entertaining style and should be read by every man who is in an executive capacity or by those in the rank and file who are ambitious to assume responsibility.

AIR BRAKE INSPECTORS' HANDBOOK. *By Carl Glenn, air brake inspector Chicago, Rock Island & Pacific. 200 pages, illustrated. 5 in. by 7¼ in. Price $2.00. Published by the Simmons-Boardman Publishing Company, 30 Church street, New York.*

The Air Brake Inspectors' Handbook, which is the second volume of the Railwaymen's Handbook Series, is a worthy companion to the Car Inspectors' Handbook reviewed in the September, 1924, issue of the *Railway Mechanical Engineer*. The author has accomplished his purpose to provide a handy reference book for enginemen and air brake

inspectors, giving prescribed tests by which to locate defects as the various symptoms appear. The tests described are useful to any man whose work requires him to operate or repair air brake equipment, particularly, as they cover all types of equipment in general use.

The text of the book contains 14 chapters on such subjects as air compressors, pump governors, the G-6 brake valve and double check valve, feed valves, triple valve defects, PC and ET equipment, the No. 6-A ET equipment, ET piping, air signal equipment and a chapter on the UC No. 12 universal passenger control valve. An interesting chapter is devoted to common defects occurring in the empty and load brake. This type of equipment is usually a difficult problem to the air brake man on account of the disparity between loaded and empty weights of modern equipment. Particular attention has been paid in this chapter to defects in the K-2-L triple valve and also in the H-3 change-over valve. A chapter has also been added in which the author has gone into the various interpretations and rulings, as applied to brake and signal equipment, of the locomotive safety laws. The volume is quite complete and should be of real service to railroad men, concerned with the operation or maintenance of air brake equipment.

PRACTICAL MATHEMATICAL ANALYSIS. *By H. Von Sanden, Professor of mathematics at the University of Clausthal, with examples by the translator, H. Levy, M.A., D.Sc., F.R.S.E., Professor of Mathematics, Imperial College of Science and Technology, London,* 195 *pages, illustrated* 5½ *in. by* 8½ *in. Price* $4.50. *Published by E. P. Dutton & Company, New York.*

The book presents to the reader an able and stimulating survey of the methods by which the solutions of any given problem may be evaluated in numerical form. The author has given preference to those methods which are capable of a very general application in the teaching of mathematics, and consequently has devoted considerable space to the treatment of empirical function.

The general theory and the three positions of the slide-rule is discussed in Chapter II. The same chapter contains an explanation of the construction and the use of the calculating machine. Other subjects treated in the book are rational integral functions, and their extrapolation and interpolation; numerical differentiation and integration; mechanical quadrature; solution of equations, linear, transcendental and non-linear and the analytical approximation of empirical function.

THE SUPERVISION AND MAINTENANCE OF STEAM RAISING PLANT. *By Charles A. Suckau,* 342 *pages,* 6½ *in. by* 9½ *in., illustrated, bound in cloth. Published by D. Van Nostrand Company, New York, Price* $8.00.

The present high cost of fuel is emphasizing the imperative need for an organized system of boiler house control. The fuel bill is the largest item of operating expense, and any means of reducing it is worthy of the closest attention. In this book the author has brought out the necessity for the efficient operation and maintenance of steam generating plants and has presented such information as will assist power plant owners and engineers to operate their plants as efficiently as possible under existing conditions in the simplest possible manner by avoiding a theoretical discussion of the subject. This volume will be found valuable as a reference work. The text is divided into two general parts, the first dealing with supervision and the second with maintenance. A practical discussion of the economical use of fuels and the use of fuel-saving devices is followed by a discussion of the operation of auxiliaries and the handling of fuel and ashes. A section of Part I is devoted to the management and duties of the power plant operating staff. Part II covers the inspection and maintenance of equipment.

PROCEEDINGS OF THE INTERNATIONAL RAILWAY FUEL ASSOCIATION 1924. *Edited by the Treasurer, J. B. Hutchinson,* 6000 *Michigan Avenue, Chicago, Ill.* 487 *pages, bound in leather.*

This book contains the proceedings of the Sixteenth Annual Convention of the International Railway Fuel Association which was held in Chicago, May 26 to 29, 1924. The reports submitted include the Proper Distribution of Locomotive Fuel; Feed Water Heaters; Symposiums on New England, Australia, Canada, South West Territory and other Central States and Mid-Continent; Oil and Coal Locomotive Fuel; Firing Practice; Fuel Stations; Coal Storage; Mining, Preparation and Inspection of Coal for Locomotive Use; Co-operation with the American Railway Association; Purchase of Coal by the Railroads; Fuel Loss at Locomotive Terminals, and What is the Responsibility of the Division Superintendent in Fuel Conservation?

What Our Readers Think

A Fast Job in the Roundhouse

MILWAUKEE, WIS.

TO THE EDITOR:

In almost every issue of the *Railway Mechanical Engineer* I read with considerable interest of work being done in a very short time, or in a better way than the general practice. Such articles are most helpful to those directly responsible for locomotive repairs for it aids them in "doing the job" and returning the locomotive to service in less time and in many cases with less effort.

I have in mind the renewal of a front side rod pin on a Pacific type locomotive which was made here in six hours. The new pin was furnished finished except for the wheel fit. The pin to be removed and applied was of the cup shaped type, the depression being made in the pin to secure a cup shaped washer by means of a 1¼-in. bolt extending through the entire length of the pin. To remove the pin the engine was spotted and the rods removed. The engine was again spotted on the right back center to place the pin in position for removal. Blocks were then placed between both of the front driving boxes and pedestals and the brakes were slacked. While two men jacked up the engine the side rod pin was cut off flush with the wheel center, then cut in as far as possible at the front and back sides of the bolt hole to within ¼-in. of the wheel bearing. It was necessary to cut the balance of the pin from the outside, as the mechanics were not able to cut the entire distance through the pin. After completing the cutting operation, the pin was cooled and then driven out with a long ram, which extended through the spokes in the left front driver, and a sledge. This operation required little effort. The wheel center was then thoroughly cooled and calipered and one of the mechanics finished the wheel fit of the new pin while the tire and wheel center were being heated. An ordinary kerosene heater was used to heat the hole in the wheel for the new pin. The side rod was taken to the shop where the bushing was bored to fit the new pin. Heating the wheel center required about 40 minutes. A thin coat of white lead was applied to the wheel fit of the new pin which was slipped into the wheel. The rods and other parts were then applied to the locomotive.

There were two machinists and two helpers on this job which was started at 7:00 a.m. The locomotive was ready to depart on a train at 3:00 p.m. No work was done between 12:00 noon and 1:00 p.m. No arrangements had previously been made to renew this pin as the locomotive had arrived on the previous night.

We have applied several pins by this method and it has proved very satisfactory. ROUNDHOUSE FOREMAN.

Heavy Freight Locomotives for the Reading

Consolidation Type Weighs 314,950 lb. and Has Unusually High Tractive Force of 71,000 lb.

IN building the order of 25 Consolidation type locomotives for the Reading Company in the latter part of 1923 the Baldwin Locomotive Works turned out the heaviest of this type which had been constructed in its plant up to that time. These locomotives have a total weight on drivers of 284,190 lb. which averages 71,000 lb. per pair. The development of the Consolidation type on the Reading presents some interesting features and a comparison of the latest group, designated as Class I-10-S A, with previous Consolidations built for this road shows the remarkable increase in capacity effected since 1880. The accompanying table gives a comparison of the principal dimensions.

As compared with the locomotives built in 1880, Class I-10-S A shows an increase in total weight of 208 per cent and in tractive force of 262 per cent. With a ratio of adhesion of four, the weight on drivers of the new locomotives is fully utilized for traction purposes.

Fuel and traffic conditions on the Reading are largely responsible for the continued use of the Consolidation type in heavy freight service. The fuel used is a mixture of fine anthracite and bituminous coal, which can be economically burned in a wide firebox placed above the driving wheels; while the traffic consists largely of coal which is hauled in heavy drags at moderate speeds. With the excellent track conditions on this road, and with generally favorable grades from the mining regions to tide-water, eight-coupled locomotives handle the heaviest trains that can be economically operated.

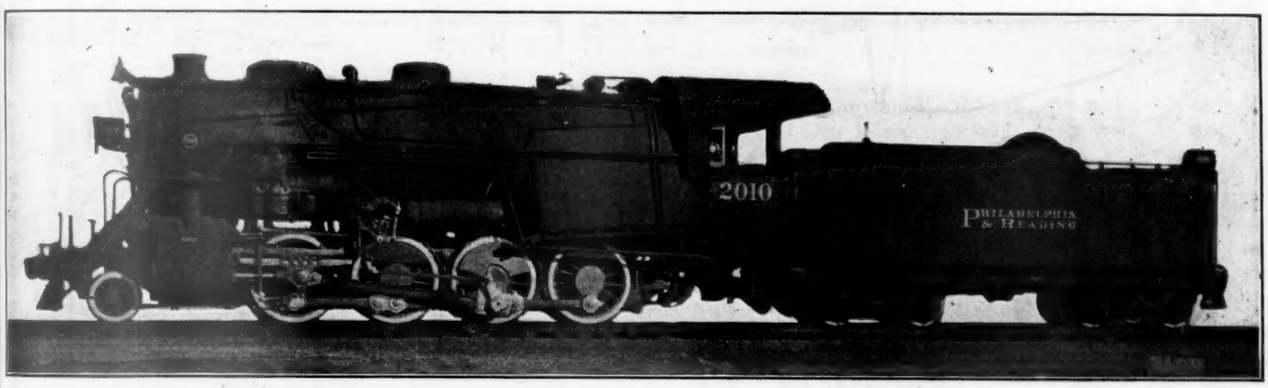
The new locomotives are a direct development of Class I-9, built in 1919, and have many features in common with them. The increase in total weight is 12 per cent and in tractive force 16 per cent. Flanged tires are used on all the wheels, and are spaced transversely to permit the locomotives to pass curves as sharp as 22 deg.

The boiler is of the Wootten type, with a conical ring forming the front half of the barrel, and a maximum diameter of 96 in. The center line is placed 10 ft. 2 in. above the rail. The firebox has a combustion chamber, across the throat of which is built a brick wall 26 in. high. A Duplex stoker is applied, and the grate is of the rocking pattern, with drop plates front and back. The ash pan has a single hopper of large capacity, with a steam blower pipe for cleaning. A special feature that should be noted in connection with the boiler is the Economy front end, patented by I. A. Seiders, superintendent of motive power and rolling equipment of the Reading. The sparks are broken up by means of a breaker plate, consisting of a slotted plate fitted with deflecting vanes, which is placed under the superheater damper and in front of the tubes. The netting frames are most substantial in construction, and the device has proved very effective in preventing the setting of fires due to escaping sparks.

Two of the locomotives in the group are equipped with the Sellers exhaust steam injector.

As in the Class I-9 Consolidation type locomotives, the cylinders are cast separate from the saddle. The valve chambers are bushed for 13-in. piston valves, but are of sufficient size to take valves 14 in. in diameter. The valves are set with a travel of 6½ in. and a lead of ¼ in.; they have a steam lap of 1 in. and an exhaust clearance of 1/16 in. They are operated by Walschaert gear, controlled by the Ragonnet power reverse mechanism. The pistons have rolled steel heads and cast iron bull rings, and the driving and engine truck axles, crank pins, piston rods, and connecting rods are of quenched and tempered steel; the driving axles are hollow bored. Fifty per cent of the reciprocating weight is balanced.

The main frames are each cast in one piece, and with the

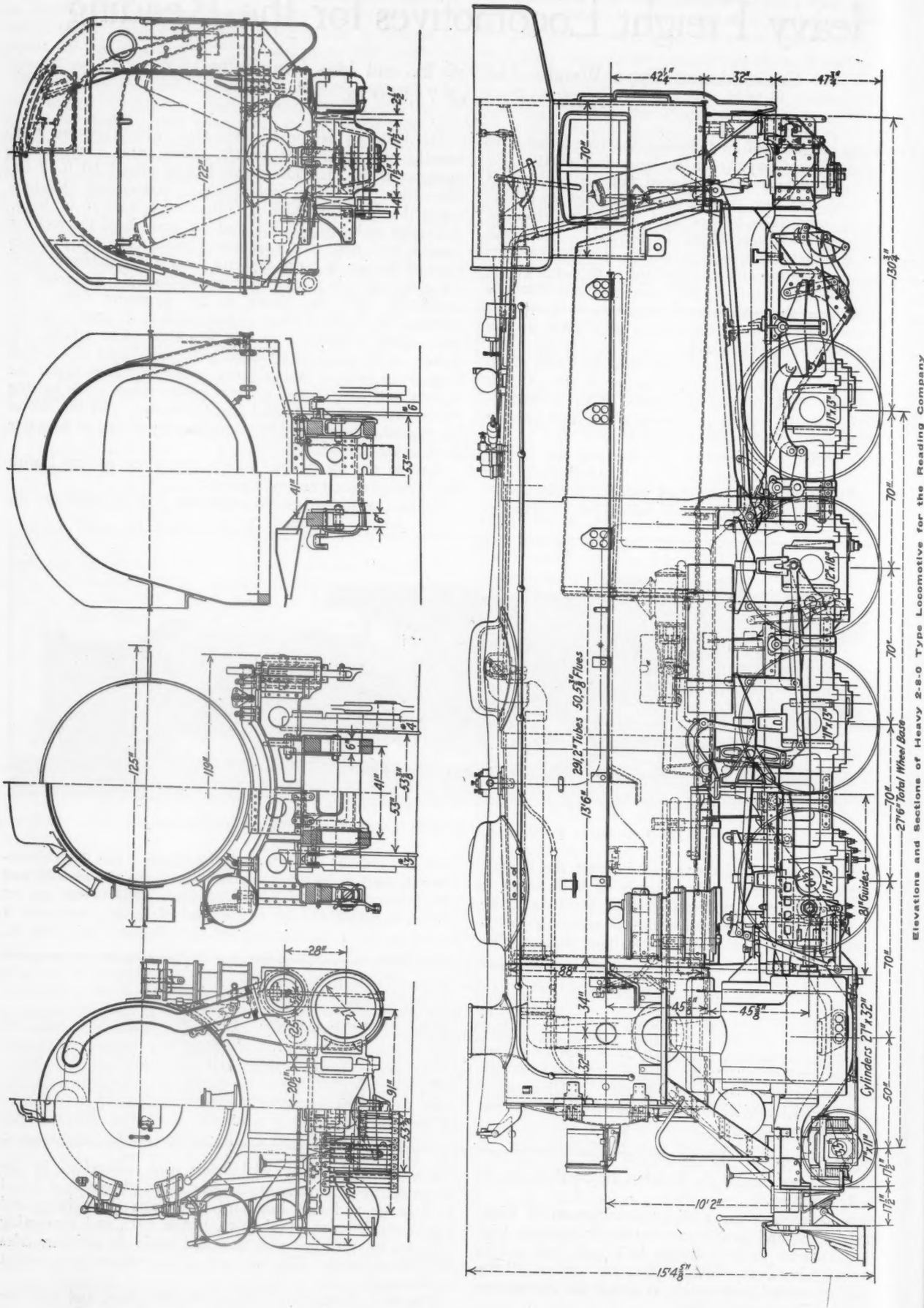


Consolidation Type Locomotive Built by the Baldwin Locomotive Works for the Reading

THE DEVELOPMENT OF THE CONSOLIDATION TYPE ON THE READING

Date built	Cylinders, in.	Drivers, in.	Steam pressure, lb.	Grate area, sq. ft.	Water heating surface, sq. ft.	Superheating surface, sq. ft.	Weight on drivers, lb.	Weight total engine, lb.	Tractive force, lb.
1880	20 by 24	50	120	76	1,357	...	90,300	104,100	19,600
1890	22 by 28	50	140	76	1,818	...	135,000	150,000	32,250
1900	22 by 28	56	200	47.5*	2,130	...	147,600	164,300	41,200
1905	22 by 30	61½	210	90	3,209	...	204,000	226,250	42,200
1919	25 by 32	55½	200	94.9	2,655	575	250,800	281,100	61,000
1923	27 by 32	61½	220	94.5	3,315	778	284,190	314,950	71,000

*Designed for burning bituminous coal.



Elevations and Sections of Heavy 2-8-0 Type Locomotive for the Reading Company

transverse braces are of most substantial construction. The front frames sections are in the form of slabs, which fit between the central saddle and the cylinder castings. The main driving boxes are of the extended type, and self-adjusting wedges are used in the main pedestals.

The tender frame is built up, with 10-in. and 12-in. longitudinal channels and steel plate bumpers. The tank carries 9,500 gal. of water and 15 tons of coal. The trucks are of the equalized pedestal type, with forged steel wheels.

These locomotives have a width over the cylinders of 10 ft. 5 in., and a height over all of 15 ft. 4⅝ in.

TABLE OF WEIGHTS, DIMENSIONS AND PROPORTIONS.

Railroad	Reading
Type of locomotive	2-8-0
Service	Freight
Cylinders, diameter and stroke	27 in. by 32 in.
Valve gear, type	Walschaert
Valves, piston type, size	Piston, 13 in.
Weights in working order:	
On drivers	284,190 lb.
On front truck	30,760 lb.
Total engine	314,950 lb.
Tender	187,050 lb.
Wheel bases:	
Driving	17 ft. 6 in.
Rigid	17 ft. 6 in.
Total engine	27 ft. 6 in.
Total engine and tender	66 ft. 10¼ in.
Wheels, diameter outside tires:	
Driving	61½ in.
Front truck	33 in.
Journals, diameter and length:	
Driving, main	12 in. by 18 in.
Driving, others	11 in. by 13 in.
Front truck	7 in. by 11 in.
Boiler:	
Type	Conical
Steam pressure	220 lb.
Fuel, kind	Anth. and bit. mixed
Diameter, first ring, inside	88 in.
Firebox, length and width	126⅜ in. by 108¼ in.
Tubes, number and diameter	291—2 in.
Flues, number and diameter	50—5½ in.
Length over tube sheets	13 ft. 6 in.
Grate area	94.5 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	327 sq. ft.
Arch tubes	
Tubes and flues	2,988 sq. ft.
Total evaporative	3,315 sq. ft.
Superheating	778 sq. ft.
Comb. evaporative and superheating	4,093 sq. ft.
Tender:	
Water capacity	9,500 gal.
Fuel capacity	15 tons
General data estimated:	
Rated tractive force, 85 per cent	71,000 lb.
Cylinder horsepower (Cole)	2,886
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	90.3
Weight on drivers ÷ tractive force	4.0
Total weight engine ÷ cylinder hp.	111.7
Boiler proportions:	
Comb. heat. surface ÷ cylinder hp.	1.45
Tractive force ÷ comb. heat. surface	17.3
Tractive force × dia. drivers ÷ comb. heat. surface	1,066.8
Cylinder hp. ÷ grate area	30.5

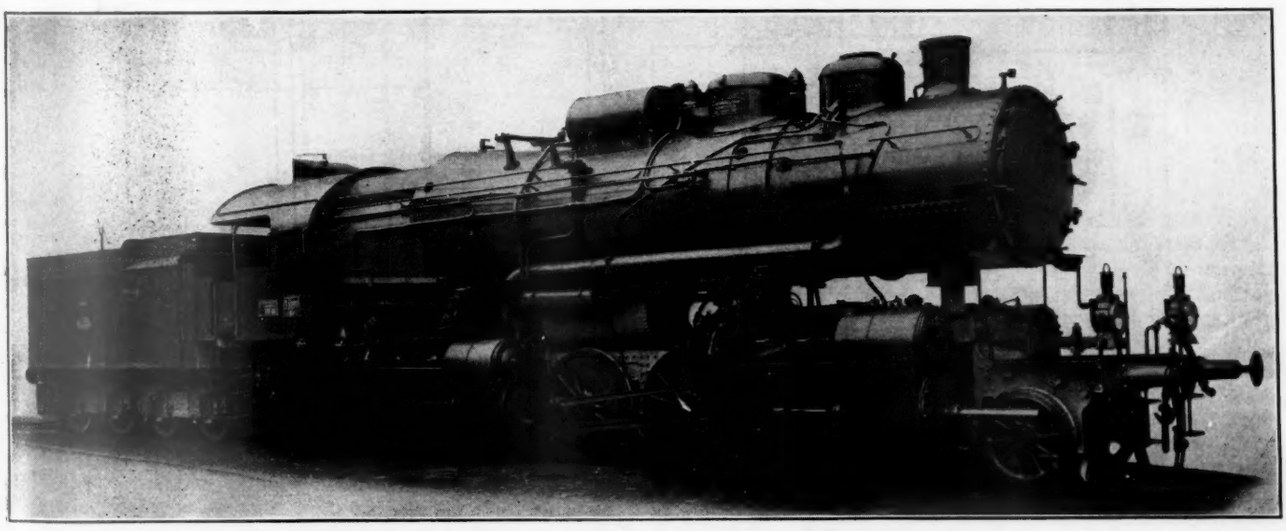
Brotan Boiler Applied to Hungarian Mallet

Adverse Water Conditions Led to the Adoption of This Type, Which Has Proved Successful

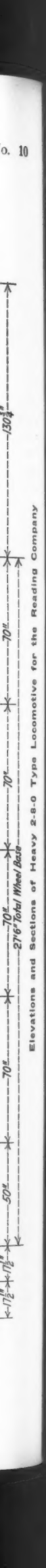
THE Hungarian State Railways had handled practically all of its heavy express and passenger trains on the Fiume-Moravica section of the Budapest-Fiume line with locomotives of the 2-4-4-0 type, and the freight trains with 0-6-6-0 type locomotives until about 1914. Increased traffic conditions since that time created the necessity of developing a locomotive of greater power and capacity. The locomotive illustrated and described in this article was designed to handle traffic in the above-mentioned territory and was the first one of its type to be built in the shops of the state railways of Budapest.

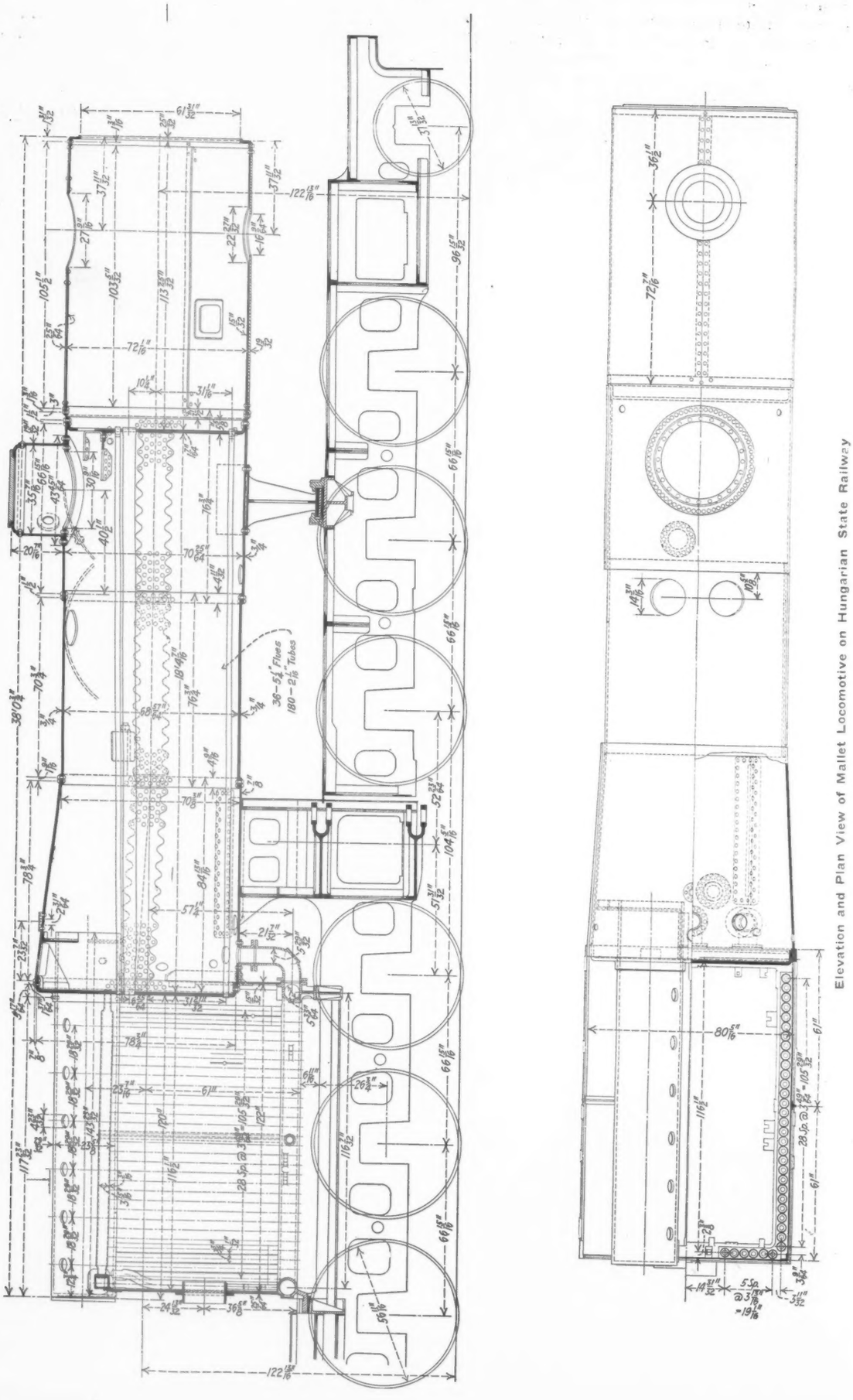
Difficulties had been experienced with the boilers on locomotives previously used in this district because of hard water and because of the highly satisfactory service which the Brotan boiler had rendered on some express locomotives, it was decided to embody it in the design of this new Mallet. Since this first locomotive was constructed, 59 more of the same design have been built and placed in service.

This particular design of the Brotan firebox boiler has a greater heating surface than is usually found in European locomotive boilers. The barrel of the boiler is in three sections; the middle section has a diameter of 68 29/32 in. and the plates are ¾ in. thick, while the rear section is conical with a maximum diameter of 78¾ in., the plates being ⅞ in. thick. The circumferential seams of the boiler are lapped and double riveted; the longitudinal seams have double straps of unequal width and are triple riveted. The copper tube sheet of the firebox is 1 3/16 in. thick, the front tube sheet is of iron 1 7/64 in. thick. The steam dome is 20 7/16 in. high and has a diameter of 35 7/16 in.; it consists of two



Mallet Locomotive with Brotan Boiler Built for Heavy Freight Service





Elevation and Plan View of Mallet Locomotive on Hungarian State Railway

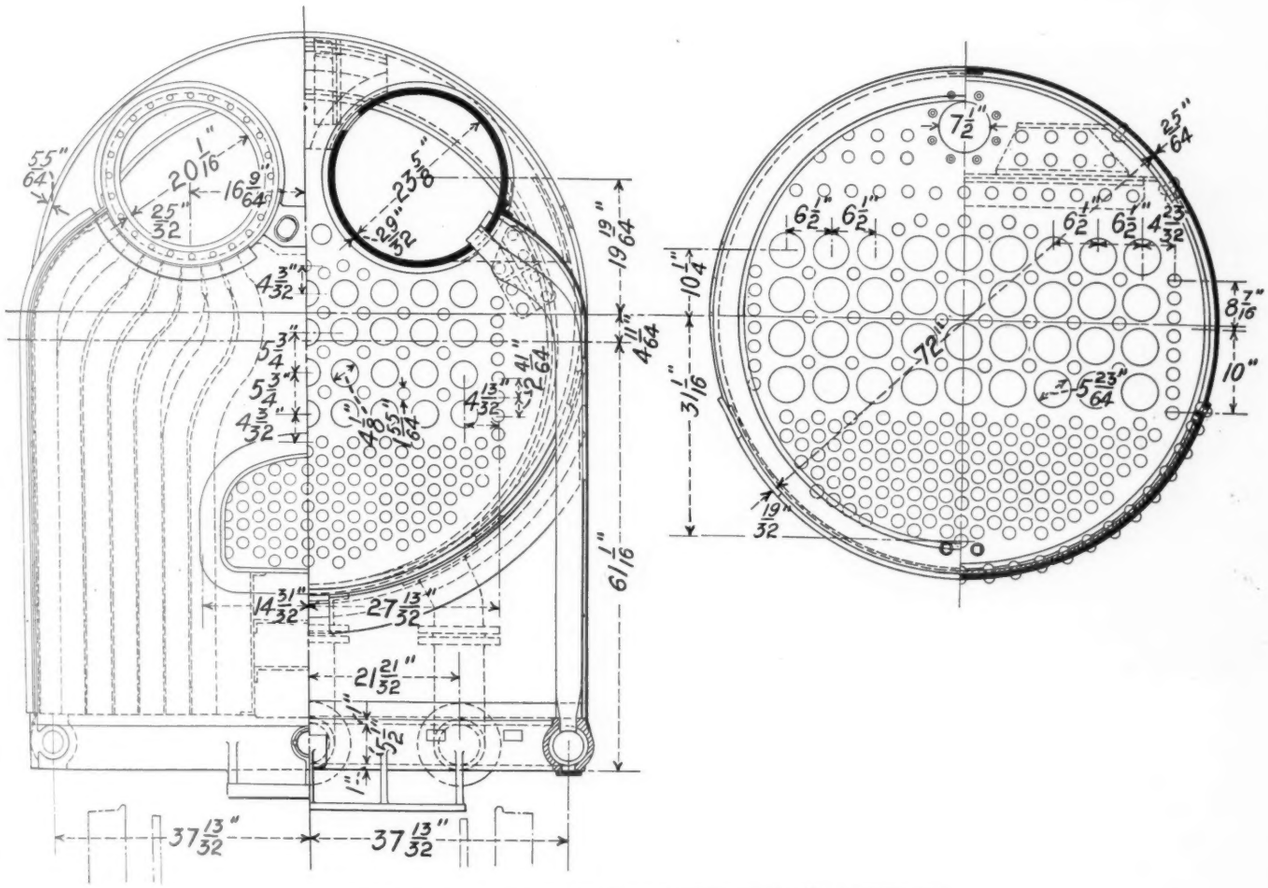
parts; viz., the flanged shell which is 19/32 in. thick, and the dome which is 7/8 in. thick and which has a cover 25 9/16 in. in diameter. The smoke box is built up of two plates and has a door consisting of two dished plates which is held against the cast steel door frame by 12 clamps. Connecting with the stack, which is not continued down inside the smoke box, is a conical, tiltable spark arrester extending down to the exhaust pipe which ends on a level with the center of the boiler. Behind the opening for the stack is fitted a half conical smoke duct.

The throttle valve on the steam dome is a double disc gate valve; two safety valves of four-inch diameter, with a high lift, are fitted on a special pad back of the dome. On account of the size of the boiler two strainers, each with six cells of 21⅝ in. diameter, were fitted, the feed water being led to these through a feed-head by means of a non-suction steamjet pump.

The Schmidt type superheater has 36 units in four rows of nine each. The Brotan type firebox, the largest of its kind, is 122 in. long between protecting plates and 79½ in. wide. The cast steel base frame is built up in four sections with flanged joints and its front end is connected to the boiler by three elbows. In later construction the base frame is in one piece. The side walls of the firebox are formed by seamless drawn wrought iron water tubes which end in two separate headers, and are connected with each other at the rear by a coupling piece. To insure tightness the headers project into the boiler for a distance of 22 9/16 in. and are there supported by heavy angle bars. Furthermore, to better shut off the gases of combustion toward the top, two more horizontal water tubes were built in between the two headers, reaching from the rear coupling piece to the tube sheet. The rear wall of the firebox is formed by six water tubes on each side, while forward a fireproof wall completes the enclosure. The fire door is a sliding door in halves, the opening being formed by a cast steel frame; combustion with but little smoke formation is attained by a long fire dome; a tilting grate serves readily to remove the slag formed by inferior coal.

The saddle connecting the cylinders of the rear truck is 59 in. deep and is rigidly riveted to the last boiler section. Thus secured, the boiler rests by means of a front and rear sliding surface of the base frame on the tie girders of the trucks, the last one of which is provided with a brass liner. Ahead of the middle axle of the forward truck is located a cast steel girder having an inside riveted connection with the boiler at the top and resting at the bottom on bushed guides. Two coupled plate springs 70⅞ in. long, having 3 15/16 in. side play bring the forward truck back to the mid position.

The ash pan has a horizontal bottom divided into two sections by a recess for the middle axle of the rear truck; each of the sections has two trap doors in the bottom which can be operated from the cab. A branch line from the left pressure pipe of the steam jet pump serves for sprinkling the coal while one from the right serves the same purpose for the ash pan.



Cross Section of Brotan Boiler on Hungarian Mallet Locomotive

Each wheel base consists of two continuous frames 1⅛ in. thick, 43 5/16 in. apart. Due to the frame for the high pressure cylinders being located under the firebox, the horizontal stiffening of this main girder was limited, but it was possible to fit, in addition to a horizontal angle frame above the closed driving box openings, several wrought iron stiffeners between the wheels at the lower edge of the frame.

The driving axle which is curved to a radius of 76 in., is fitted with upper supporting springs of eleven plates each and

has 1 21/32 in. play on each side. The supporting springs of all driving axles are below and are connected up by two spring links; they consist of twelve plates with 35 7/16 in. hanger centers. The last wheel of the forward truck has smaller flanges, the first wheel of the rear truck has ½ in. lateral on each side, and the second and seventh axles of the locomotive run in fixed bearings. The flanges of the first, second and fifth wheels, which are subject to the most wear on curves, are lubricated. The connection of the two truck frames is located somewhat ahead of the center of high pressure cylinders, there being long swivel pins in the cross tie of the latter.

For the distribution of steam, outside valve gear of the Hensinger-Walschaert type and piston valves are employed. A hand operated starting slide valve at the right hand side of the boiler takes the live steam from the steam supply pipe and allows it to pass on to the cross connection, the air valve of which limits the pressure to 110 lb. In most cases, especially in freight trains which are never coupled taut, the high pressure cylinders alone suffice for starting.

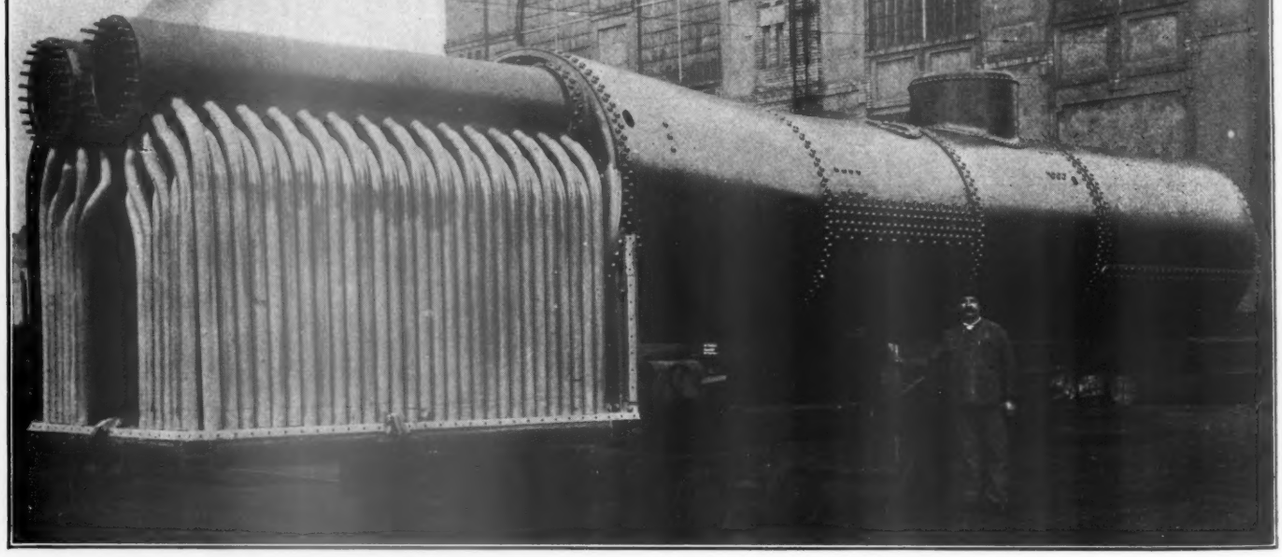
with a braking power equal to 69.6 per cent of the weight on drivers; a speedometer for a maximum speed of 37 m.p.h.; a sander operated by compressed air which takes sand from a large sand box and throws it in front of each front driver. In addition to this a small sand box, attached to the cab, is provided for the driving wheels of the rear truck. The forward part of the frame is arranged for fitting a snow plow.

The cab has sliding windows at the sides, a ventilating hood and an acetylene ceiling lamp. Each header on the boiler is equipped with a water gage; gage cocks are not provided.

The tender has four wheel trucks which are equipped with the same brakes as the locomotive.

Table of Dimensions, Weights and Proportions

H. P. cylinders, diameter	20.47 in.
L. P. cylinders, diameter	33.46 in.
Stroke	25.98 in.
H. P. piston valves, diameter	9.84 in.
L. P. piston valves, diameter	13.39 in.
Weights in working order:	
On drivers	214,000 lb.
On front truck	27,000 lb.
Total engine	241,000 lb.
Tender	126,000 lb.
Wheel bases:	
Driving	27 ft. 8⅝ in.
Rigid	11 ft. 1⅞ in.
Total engine	39 ft. 0½ in.
Total engine and tender	63 ft. 0 in.
Wheels, diameter outside tires:	
Driving	56.69 in.
Front truck	37.40 in.
Boiler:	
Steam pressure	220 lb.
Diameter, first ring, inside	68.9 in.
Firebox, length and width	122 in. by 79½ in.
Tubes, number and diameter	180—2¼ in.
Flues, number and diameter	36—5½ in.
Water tubes	70—3¾ in.
Length over tube sheets	18 ft.—6¾ in.
Grate area	54.7 sq. ft.
Heating surfaces:	
Firebox and water tubes	247 sq. ft.
Tubes and flues	2,671 sq. ft.
Total evaporative	2,918 sq. ft.
Superheating	857 sq. ft.
Comb. evaporative and superheating	3,775 sq. ft.
Tender:	
Water capacity	6,800 gal.
Fuel capacity	8.8 tons
Rated tractive force, 75 per cent	61,500 lb.
Weight proportions:	
Weight on drivers ÷ tractive force	3.48
Total weight engine ÷ comb. heating surface	63.9
Boiler proportions:	
Tractive force ÷ comb. heating surface	16.3
Tractive force × dia. drivers ÷ comb. heating surface	9.45
Firebox heating surface, per cent of evap. heating surface	9.3
Superheat. surface, per cent of evap. heating surface	32.0



General View of the Brotan Boiler Showing Arrangement of Water Tubes and Drums

The rear stuffing boxes of the piston rods are fitted with metal packing; the piston rods of the high pressure cylinders do not extend through, while the low pressure piston rods extend through at the forward end and run in enclosed guides. In the first two locomotives built, two large air-suction valves were fitted in the steam supply pipes while in the later ones they were mounted on the steam chest. All cylinder heads have safety valves to guard against excessive pressure.

Reversing is accomplished by a threaded spindle operating on a main shaft located to the rear of the high pressure cylinders; from this shaft tie rods on each side connect with the valve operating rod of the low pressure cylinders as the firebox interferes with running this rod continuously as is usually the case. The tie rod connects from the center with the valve operating rod of the high pressure cylinders in such a way that it is free to follow the movements of the truck.

The adjustable screw coupling between the locomotive and the tender is designed for a pull of 23 tons as required by the standard specifications.

Forming part of the equipment is the automatic Westinghouse emergency brake and the non-automatic Henry brake,

Traveling Engineers' Association Meets at Chicago

President Howley Stated That Co-operation Between the Executives and the Association Was Necessary to Secure Definite Results

DURING the opening session of the thirty-second annual convention of the Traveling Engineers' Association which was held September 16 to 19 inclusive, at the Hotel Sherman, Chicago, considerable stress was laid on the importance of those attending the sessions to wholeheartedly enter into the discussion of the various papers as they were presented. It was further pointed out that the exchange of ideas means progress in any line of endeavor and that it is particularly needed by the members of this association because of the rapid changes in locomotive construction. Each member attending the sessions should at least take home one new idea.

The convention closed with the election of the following officers for the ensuing year: President, W. J. Fee, Canadian National; first vice-president, J. N. Clark, Southern Pacific; second vice-president, J. E. Hurley, Wabash; third vice-president, J. D. Heyburn, St. Louis-San Francisco; fourth vice-president, James Fahey, Nickle Plate; fifth vice-president, Ralph Hammond, New York, New Haven & Hartford. David Meadows, Michigan Central, was re-elected treasurer, and the following were elected new members of the executive committee: A. N. Boyd, Canadian National; G. C. Jones, Atlantic Coast Line; H. B. Kelley, Pittsburgh & Lake Erie; Robert Collett, St. Louis-San Francisco; H. H. Wilson, Baltimore & Ohio, and C. J. Evans, Missouri-Kansas-Texas.

The program was arranged to cover the following subjects: Locomotive Boosters; The Stoker Fired Locomotive and the Future Engineman; How to Improve Oil-Burning on Locomotives; Lubrication and Its Effect on Locomotive Service; Conservation of Locomotive Fuel; Handling Passenger and Freight Trains; The Work of the Traveling Engineer, and Automatic Train Control. The principal addresses were given by R. S. Parsons, vice-president of the Erie; A. G. Pack, chief of the Bureau of Locomotive Inspection, and President Howley. Brief addresses were also made by G. A. Kell (Canadian National) and C. M. Kidd (Virginian), president of the Air Brake Association. Abstracts of Mr. Pack's and President Howley's addresses and some of the more important reports and papers are given in the succeeding columns.

Address by President Howley

In his address at the opening session, the president, T. F. Howley (Erie), spoke in part as follows:

It is particularly gratifying to me and the other officers of the association to note the large attendance of our membership. This tends to signify your interest in the personal benefits that are to be derived by each one of us through the papers to be presented, the discussions that will follow and the opportunity afforded, through the intermingling of men, all engaged in the same line of business, to learn how other railroads handle problems such as may perhaps be now confronting you.

It also seems to indicate an interest in this association on the part of the higher officers of the railroads we represent, as is evidenced by their granting us permission to attend this meeting and an apparent belief on their part that our work in the duties assigned to us is going to be improved thereby and the results attained in locomotive service are going to be bettered through such attendance. This is something our association can well be proud of as it bespeaks that co-operation between officers so necessary to secure concrete results.

T. F. Howley (Erie)
President

W. J. Fee (Grand Trunk)
First Vice-President

J. N. Clark (Southern Pacific)
Second Vice-President

Changes in Locomotive Construction

Constant changes being made in locomotive construction, including equipment and improved methods of operation require the traveling engineer to be constantly on the alert in order to keep abreast of the times, and probably in no other way can this be better accomplished than through the annual meetings and interchange of views as carried by this association, composed as it is of the traveling engineers of almost every railroad in the country.

The motto of our association, "To improve locomotive service on American railroads," backed up by 31 years of earnest endeavor to keep our members up to date in relation to the latest changes in locomotive construction, appliances, improved methods of firing, best methods of handling on the part of enginemen with a view of securing greatest economy in performance and increased safety in operation, cannot well help but appeal to the higher officer who is en-

deavoring to obtain the best results on the railroad which he is assisting to operate.

It is the aim of this association as you know, to present at each meeting a number of papers dealing with the latest information obtainable, both in connection with locomotive features in use for years past and also in regard to newly brought out devices and methods intended to improve locomotive operation. Thus from time to time we have papers having reference to such old time devices as lubricators and injectors tending to keep us up to date in connection with improvements in such devices, papers dealing with breakdowns of locomotive machinery and failures of various appliances and the most practical ways of overcoming them, papers on safety devices, examinations of enginemen and firemen and papers dealing with such new devices as the booster, feed water heater, boiler syphon, etc.

Value of Discussion

In order that each one of us may gain as much useful knowledge during our present sessions as is possible, make a wholehearted effort to discuss each paper thoroughly here in the open meeting where the committee presenting it will have the opportunity to tell you how and why they reached their conclusions. Give us the benefit of your individual knowledge and experience as other members will give you the benefit of their experience. Then we can each of us return to our homes feeling that the improvement we can show in our work through better understanding and more complete knowledge will not only justify to our superiors the expense involved in our attendance at this meeting but will assist in strengthening in their minds the belief that it is to the interest of every railroad to send its traveling engineers to these conventions if they would keep them informed as to the latest developments in connection with locomotive equipments and operation.

J. B. Hurley (Wabash)
Third Vice-President

J. D. Heyburn (Frisco)
Fourth Vice-President

W. O. Thompson (N. Y. C.)
Secretary

Locomotive Maintenance

By A. G. Pack

Chief of the Bureau of Locomotive Inspection

The railroads have become as necessary to society as are the veins that carry the life blood to the various parts of the body. They distribute the commerce of the nation to the points where it can serve the most useful purpose. The locomotive is the heart of transportation and serves the same function for the railroads as the heart does for the body. Unless the heart acts efficiently the blood ceases to circulate freely and the limbs become paralyzed; unless the locomotive is maintained in a high state of efficiency, the arteries of transportation clog and business becomes stagnant and confused.

In considering the subject of locomotive maintenance, I do not come before you with new and untried theories. Everyone of you know what should be done, therefore, it generally becomes a question of doing or not doing that which you know should be done. The question arising is, "are you permitted by those in authority over you always to do the things that you know ought to be done at the proper time and place?" The Locomotive Inspection Law has placed upon every common carrier by railroad, a solemn duty, viz., to so construct, equip, and maintain their locomotives that they may be operated without unnecessary peril to life or limb; and has placed upon you, as employees of such carrier, the same solemn duty. It has given you an authority which cannot be properly evaded, and one which if taken advantage of will help you in having the things done that your training and experience has taught you should be done.

Enginemen, Like Other Workmen, Need Good Tools

The duties of locomotive enginemen are among the most hazardous and exacting. If they are successfully to perform the duties to which they are assigned, they must be active and alert during every minute and every second from the time they take charge of the locomotive at the terminal until they are relieved at their destination. Locomotive enginemen are the one class of people who cannot afford to make mistakes or allow their memories to lapse; they too often pay the penalty with their lives, and the lives of those intrusted to their care. If the engineman is not provided with a machine, in other words, tools, in good condition capable of performing the work expected, it may not be expected that he can keep his mind concentrated on his many duties, and at the same time operate his locomotive to the best advantage.

The Significance of Engine Failures

The many complex appurtenances and appliances which have been added in more recent years to make the locomotive more efficient and capable, require constant care if they are to be maintained in condition to serve the desired purpose. When minor or running repairs are neglected, it adds to the burden of operation and leads to engine failures, breakdowns and train delays. Every engine failure—so called—while on the line of road carries with it the potential of a serious and probably fatal acident. I have never found anyone who could estimate the cost of the average engine failure.

Interfere With Dispatching

Engine failures upset the prearranged plans of the train dispatchers, cause serious confusion on operating divisions, and have been known, in many instances, to lead to some of the most disastrous and costly wrecks. Many engine failures are caused by the failure to make repairs to defects of the most trivial nature. It has been charged, not however in general, that the defects to which federal inspectors take exceptions are of a trivial nature and that the repairs to such defects are trivial, with which I agree; but, when the failure of parts and appliances of the locomotive and tender cause injury and death and the serious loss of property, of which we have many records, it cannot be considered as a trivial matter. The proper time and place to make repairs is at the terminal and before locomotives are offered for service. It is better, viewed from any angle, to have trains delayed at the terminal than it is to have engine failures, break-downs, and serious accidents while on the road.

The Importance of Adequate Facilities

In considering locomotive maintenance, the subject naturally divides itself into two parts—classified repairs and roundhouse repairs. The backshop is the place where the heavier repairs should be made. The roundhouse is the place where the lighter or current running repairs should be made. When classified repairs are made in roundhouses or when running repairs are made in back-shops, the logical order of things is violated and consequently, unsatisfactory and inefficient results are obtained. It is not uncommon to find large portions of roundhouses blocked with locomotives undergoing classified repairs which could be more promptly and economically made in the backshops, while locomotives which should receive terminal attention in the roundhouse are being repaired on the outside without facilities and where men are compelled to work under the most adverse conditions, exposed to the elements. It goes without saying that such methods tend toward improper repairs and higher cost of maintenance with extremely unsatisfactory results.

Some carriers have given a great deal of attention to shop and enginehouse facilities and to providing modern tools and machinery for dismantling, repairing, and assembling locomotives, until today we have many examples exemplifying the highest state of the art. These should be given earnest consideration by carriers that have not kept pace with the changed operating conditions and in providing and maintaining adequate shop and enginehouse facilities. Inadequate shop facilities and poor organization mean failure to make the best use of our resources; they mean higher labor cost and the added cost which results from holding locomotives out of revenue service, with the necessity for a greater number of locomotives to handle a given business. Terminal and shop facilities are potent dividend producers or reducers in proportion to the methods pursued and the efficiency of organization.

Make Repairs Currently

It seems hardly necessary to urge the importance of making proper inspections and proper repairs currently, because the results of failure to do this are too well known and because it is to the interest of everyone connected with the operation of railroads to have these things done. Nevertheless, during the past 13 years federal inspectors have been compelled to order withheld from service 48,836 locomotives because of defects which unnecessarily increased the peril of operation and decreased the efficiency of the locomotive. Practically all of this number had been pronounced ready for service or were actually in service with defects constituting violation of the statute and of economic law.

Comparing engine failures, one road with another, is of little value because no standard has been fixed. There is, however, no better index as to the condition of locomotives than an accurate comparison of engine failures on a given road.

This was very forcibly brought to my attention about a year ago on one particular line where we were encountering considerable difficulty in having the requirements of the law complied with. A vice-president went so far as to request that the federal inspector in that district be removed to some other district because of alleged prejudice. This vice-president requested a conference with me at which the superintendent of motive power was present, when the conditions to which exceptions had been taken were discussed in their various details. The conclusion was reached by this same vice-president, that he wanted the inspector about whom complaint had been made to stay on his line and wished that he had more inspectors on his line because they were developing and putting before the management the conditions that cause engine failures, train delays, accidents and injuries. What has been the result? During one year there were about 400 engine failures per month with an average of 3,545 miles per failure. A year later the number of engine failures per month had been reduced to about 90 and the miles per engine failure had been increased to about 15,000. This is a vivid contrast between proper and improper inspection and repair. Proper maintenance of locomotives increases the earning power of any railroad, while improper maintenance reflects itself indirectly in unnecessary expenditure.

Factors in Good Boiler Service

No locomotive is better than its boiler. Marked advances have been made in the design and construction of locomotive boilers, while the original principle is still retained, tending toward better circulation of water and better distribution of expansion strains. No matter how well constructed a boiler may be, it cannot be safely or efficiently operated without current inspections, tests, and repairs. No one disputes this but it is surprising to learn the large number of locomotives upon which defects have been reported trip after trip and day after day and still continued in service without regard to the peril created or the monetary loss indirectly incurred.

One of the first considerations in maintaining boilers is that of water supply. Those of you who are connected with the operation of locomotives in bad water districts know of the problems arising from this source, both from the maintenance view-point, and of getting over the road with a train. Too much cannot be said for the necessity of removing all washout plugs and thoroughly washing all parts of the boiler as often as water conditions require. It is too often true that boiler washing is neglected, which is always reflected by increased trouble and cost of maintenance. When sheets are coated with scale, thus insulating them from the water, the water cannot absorb the heat readily and the result is increased temperature and strain with a corresponding increase in trouble and decrease in evaporation.

Marked improvements in water supply have been made in many places by the installation of treating plants and in others by changing the source of supply. Conditions have been vastly improved, in many instances, by installing modern washout systems. These improvements cost money, but when one considers the reliability and efficiency of service that is today required of locomotives, it becomes apparent that any reasonable expenditure in providing better water and proper washing facilities is ultimately a paying proposition. There is a close and inseparable relation between locomotive maintenance and fuel economy. The increased cost of fuel has made it a matter of prime importance and is attracting the widest attention among the railroad managements at this time.

Efficiency and economy of operation has caused the application of brick arches, superheaters, combustion chambers, feed water heaters, thermic syphons, and many other appliances, which must be properly maintained if the desired

results are to be accomplished. Since steam is the propelling power the problem to generate it freely and to use it economically is an all important question. To this end locomotives should be so maintained that the distribution of the steam to the cylinders be most effective, and that the machinery be in condition to utilize the energy created to the highest possible degree. Rod bearings which are loose and in bad condition, boxes loose on journals, shoes and wedges out of adjustment, loose and worn cylinder packings which blow, valves out of square and blowing, are poor mediums through which to transmit the energy; they adversely affect the drawbar pull and the earning power of the locomotive.

The Monthly Budget Not a Promoter of Stability

One of the unfortunate situations confronting the mechanical departments is the manner in which their appropriations are made. It is my thought that an annual, instead of a monthly, budget or allotment should be made. One of the most important considerations in the matter of locomotive maintenance is to have a corps of competent, steady, reliable, and contented employees. We must have contentment if the best results are to be obtained; discord and confusion among employees is not conducive of the best results. Discontentment and confusion are bound to ensue when employment is uncertain and irregular.

There is nothing which so adversely affects economy of locomotive maintenance as to tear the mechanical organization to pieces each month or at frequent intervals in order to keep within the appropriation or to fluctuate the personnel with every temporary traffic change. I appreciate that revenues can not be disregarded when making expenditures, but, with proper consideration, forethought and foresight, expenditures can be anticipated with sufficient accuracy and the mechanical forces so regulated as to provide steady employment. Steady employment at remunerative wages brings about a satisfaction among employees that is hard to disrupt; on the other hand, when men are treated as machines and laid aside without regard to consequences, and without sound reason, it breeds bolshevism, unrest and disloyalty, and brings hardships, not only upon the men thrown out of employment, but upon everyone connected with the organization.

Again, locomotives cannot be properly and economically maintained if repairs are neglected until the rush period is on. It is then that the locomotives should be in revenue service and not in the shop; it is then that the transportation department is pressing for motive power. Therefore, in keeping with sound management the locomotives should be repaired in the dull period and be available in a high state of repair when the rush comes, if traffic is to be most efficiently and economically handled.

Locomotive Boosters

The demand for efficiency and economy in locomotive design and service is increasing every day. Every new idea that can be worked out successfully along those lines is speedily accepted by railroad managements. Consequently when the booster idea was conceived and grew into a working model and a very successful one, it has met with most gratifying success in a short time, being used first on the New York Central in 1919.

The greatest difficulty in handling a maximum tonnage train is in getting it started as well as getting it over the grades. It is a well-known fact that the tractive effort necessary to start a train is far greater than the effort required to keep the same train in motion. It is also true that the horsepower the locomotive develops is greater while in motion than when starting from rest.

For many years enginemen have worked on this principle without success, until in 1918 H. L. Ingersoll, assistant to the president of the New York Central, developed the booster and brought it to its present high standard of efficiency. It is now considered a necessary appliance and has been placed on over 1450 locomotives on 43 different railroads in the United States and Canada, and applications have been made on locomotives on several foreign roads.

The locomotive booster is a horizontal two-cylinder double-acting steam engine mounted on the trailer truck and connected directly to the trailer axle of the locomotive through suitable gearing by which it may be engaged or disengaged at will.

It is designed for applying power to the trailer wheel in the *forward motion only*. It cannot be operated when the engine is in back motion.

It is self-contained and has a flexible mounting in the form of a three-point suspension. Bearing on the trailer axle are two of the points, while the third is the spherical seat at the center of the rear cross member of the truck frame, which latter allows free movement of the booster with the varying positions of the trailer axle.

The engine is a very simple type, consisting of two 10-in. by 12-in. cylinders with piston valves taking steam direct from the dome or from the steam chest. Steam is admitted to the cylinders three-quarters of its stroke and has no variations in cut-off.

Steam admission is controlled automatically at the will of the engineer. Exhaust steam passes through flexible connections from the booster engine to the atmosphere through the exhaust nozzle and stack.

The machinery of the booster consists of a crank-shaft driven by the booster engine which in turn drives the idle gear so placed as to mesh with another gear on the trailer axle, by means of the automatic air-operated clutch, driving the trailer axle, thereby making a temporary driving axle to assist the main driving axles in starting or exerting increased effort as needed.

When the train reaches a speed of about twelve miles per hour, the idler gear is automatically released by the reverse lever which is pulled back to reach a pre-determined point so it disengages the latch of the pilot valve, or the engineer can disengage it by knocking down the booster latch. The booster then is inoperative, in which condition it exerts no power, but is available when extra power is needed.

The purpose of the booster is to provide additional starting effort, increased power for acceleration and additional tractive effort on grades.

It can be attached to the trailer truck of the locomotives and is a reserve power that can be quickly applied when needed and as quickly released when not needed.

It can be used in starting trains and its power utilized until they reach a speed of twenty miles an hour, when it should be disengaged.

The starting power of the locomotive is governed by the weight carried on the drivers. The trailer axle usually carries as much weight as one pair of driving wheels. Various ways have been devised to utilize this idle weight of the trailer wheels and axle and divert them into driving wheels.

This is where Mr. Ingersoll's idea has been successfully developed. He realized that to apply his idea correctly certain limitations and functions must be considered, such as the minimum amount of changes to be made on existing locomotives, not disturbing the relation between the fire-box trailer axle and the diameter of the trailing wheel, installation of the power units so that it would deliver the torque to the trailer axle without in any way affecting the action of the rear end of the locomotive, obtaining additional power only at starting and low speeds, when the boiler can supply more steam than the main engine can utilize, that the power unit should normally be controlled by the engineer but should be inoperative automatically after the locomotive has attained a pre-determined speed, and that there should be

no interference with the functioning of the locomotive at high speed.

The booster is an advantage in both passenger and freight service, as an aid to smoother starting and quicker acceleration which results in greater comfort to passengers, as an assistance of sufficient power to start trains under adverse circumstances and increased tonnage, it avoids taking the slack in starting trains, resulting in reduced cost of equipment maintenance, and also in many cases the use of expensive helper service is eliminated. It increases the ton miles per hour per locomotive over a division.

It is of equal importance in hump and transfer service, as it assists in starting trains with less damage to equipment. Tests in yard service show there was an increase of about 15 per cent more cars handled per engine than by the same class of engine without a booster. In the ability to add increasing starting and accelerating power to existing locomotives lies the hope of lower transportation costs through more tonnage haul per unit.

Boosters now in service show an addition in starting power to the Santa Fe type of 10 per cent, the Mikado type of 23 per cent, the Pacific type of 27 per cent, and the Atlantic type of 36 per cent.

The effect of the booster on the locomotive is merely an increase of 5 per cent in static stresses, which is well within the allowance in specifications for bridges, buildings and other mechanical construction.

The increased power has decreased by almost one-half the time required to get trains to road speed. By providing the extra power needed to give a smooth, steady start, the booster locomotives avoid the necessity of taking slack, thus reducing draft gear maintenance, which is one of the largest items of freight car repairs.

The operating results that are being secured by a booster equipped Mikado over the 100 per cent tonnage rating of 23 Mikados which are not booster equipped, is as follows:

Increased tonnage ..... tons	392
Ton-miles per day	39,200
Ton-miles per 100 miles for 30 days	1,176,000
Additional monthly earnings, $.0007 per ton-mile	$8,232
Additional freight, one way only	$4,116
For one year (300 days in service)	$41,160
Revenue ton-miles compared with total ton-miles ..... per cent	67
Actual increased earnings	$27,577

The report was signed by W. H. Corbett, (M. C.), chairman; J. A. Talty, (Franklin Railway Supply Company); H. L. Symons, (D. & H.), P. H. Ryan, (I. C.), F. W. Stoll (N. Y. C.), and W. B. Smith (B. & A.).

Discussion

Practically all the members who discussed this paper indicated a favorable opinion of locomotive boosters in view of their performance to date. One of the members said that they enable the tonnage rating of freight locomotives on his road to be increased 300 tons, another member said 500 tons and still another, 1,700 tons. Presumably the difference is accountable for by local conditions and gradients on the different roads. The favorable effect of the booster in enabling passenger locomotives to start heavy trains of steel cars without taking slack was pointed out. The consensus of opinion seemed to be that the best results are secured when the booster is piped to operate on superheated rather than saturated steam and when one man is regularly assigned to care for the boosters at the enginehouse and see that they are properly oiled and maintained. The records show that approximately one quart of car oil a month and one-half to three-quarters of a pint of valve oil are used, provided there are no leaks.

James Fahey, (N. C. & St. L.) said that boosters have been tested, using a dynamometer car over a period of one year and seven months, and, in view of the satisfactory results achieved, they are now being applied to heavy power, three at a time at the enginehouses without waiting for the locomotives to go to the back shop for heavy repairs. Mr. Fahey also testified that the boosters are responsible for reduced fuel consumption, that little difficulty is encountered due to maintenance, and that in the winter trains have been found frozen, but with the boosters still operative.

While one member said that in his experience the operation of the booster for six minutes would cause a reduction in steam pressure, other testimony was to the effect that the boosters have operated in certain cases as long as one hour and seventeen minutes on a grade without causing a material reduction in steam pressure.

The only criticism developed regarding the booster was the necessity of keeping the various air pipes absolutely tight in order to keep the booster operative. One member also said that he had had a broken main rod and loose crank pins which necessitated the removal of the boosters from the trucks and required considerable work before the necessary repairs could be made. Other members on the other hand claimed to have had almost no difficulty due to the maintenance of the boosters and in one case the only work needed after 45,000 miles of service was to re-pack the piston rods.

It was pointed out that in freight service the booster should be cut in when speeds fall to 10 miles per hour in order to get the best results rather than allow the speed to get too low. In passenger service, one member said that the booster should not be cut out until a speed of from 15 to 20 miles an hour is attained as in this case the utmost advantage is taken of the booster to secure rapid acceleration. Like all other locomotive devices, the boosters can be misused and abused by enginemen who do not understand them. The advisability of getting a little sand on the track before starting the booster was brought out in the discussion. The cost of a booster applied was said to be $7,500, an amount quickly repaid by the increased earning power of the locomotive.

Stoker Fired Locomotives and the Future Engineman

The modern locomotive and the present-day train cannot be handled successfully by skill and instinct only. In addition it requires rare judgment, thought and resourcefulness. This can only be obtained through the exercise of the mental faculties, and as the exercise of the mental faculty presupposes a mind or brain, we get right back to the first proposition, that it takes brains to run a locomotive. And thus we have as the first part of our problem the fact that the engineer, to be an engineer, must have a good active brain.

The next part of our problem is: Where will we get this man? It is becoming more and more difficult to obtain the right kind of men from whom we must draw to get the future engineman. As our only source of supply is from the left side of the engine, it follows that the fireman must have brains or he cannot become an engineman.

Granted that we set out to employ a man who can think. We place him on a large hand-fired engine to learn the art of firing. When he looks back he sees from 16 to 20 tons of coal staring him in the face. On the deck he sees a large scoop, a coal pick and a clinker hook. He turns around and sees a fire-door which, when opened, pours out a stream of heat that will burn his overalls off if he gets too close, and near the door a shaker bar and a bunch of shaker levers. He is told that all he has to do is to crack the coal, throw it into the firebox, and then shake down the ashes.

He looks all around and sees men employed in gainful occupations and has a fairly accurate idea of what their wages are. He sees men building a house and visions the time when each of these, the carpenter, the bricklayer, etc., can, by proper application, become contractors. In fact, every place he looks he sees possibilities of promotion, until he looks at the fireman and then he begins to figure: "Let

me see—I am twenty-one now; if promotion continues as slow as at present, I will be nearly forty before I am promoted. I wonder if the romance of the calling won't be somewhat worn off by that time—I wonder."

To hold this man on the job, we must try to get back to the old system as near as possible. True, we cannot hurry promotion; neither can we go back to the small engines, nor can we (even if we so desired) stop the march of industrial progress in those other directions that hold out possibilities to the young American, but we can make the fireman's work more attractive by making it easier. We can fire locomotives mechanically and thus relieve him of the hard manual labor and give him time to think and study to fit himself for the position he aspires to.

Do you think if a student fireman who has decided to take up railroading as a lifework, gets on a stoker-fired engine, he will quit the job after one round trip? If you do, you are not familiar with human nature. On the contrary, he will become so interested that he will not be satisfied until he masters the machine, and by that time he will see that there are other possibilities ahead of him in railroading besides running an engine, if he only applies himself; but when a man is worn out physically you can't expect much from him mentally, and the thinking man realizes this and gets off.

Going back to the beginning—if we want to maintain the high standard of enginemen that we have at present and that the service demands, we must begin with the fireman. Of course, we appreciate the fact that on all railroads there will always be hand-fired engines. The thinking man will realize this also, and so long as these engines are within the capacity of the fireman he will not let that stand in the way of his accepting service, as he can see that after his term on the hand-fired engine has been served he will get a stoker-fired engine, a job that aside from the pay is nearly as good as one on the right side. And the ultimate effect will be that the present high standard of enginemen, of which we are all justly proud, can and will be maintained, and the railroads will derive benefits through better train and engine handling far in excess of the financial outlay.

Your committee for a number of years has watched the evolution of the mechanical stoker and its increased efficient operation by the fireman. We also have noticed the increased knowledge pertaining to locomotive operation that the regular assigned stoker fireman has absorbed. In the past when we had all hand-fired engines if you asked a fireman how much coal he used on the trip, he would usually answer: "Oh, I don't know—about two tanks full." Nowadays it is different. On the road with which your chairman has the good fortune to be connected it is not unusual to get up on our stoker engines and ask the fireman: "How is the fuel consumption showing up on this engine?" He will answer right off: "Oh, about so many pounds per 1,000 gross ton-miles or per passenger car-mile." And that is not all. He will tell you whether or not the evaporation of water per pound of coal is what it should be and a good many other things that he did not know while on the hand-fired engine. He will talk to you about the air openings in the ash-pan, and why he has to carry a lighter fire on one engine and a shade heavier on another.

Now why can this fireman talk so intelligently about locomotive operation? Because with the stoker-equipped engine he has time to think and study. Let me give you one example of a fireman who had learned to think. Your chairman was operating a locomotive with 100 tons over the rated tonnage of the locomotive. In order to make a meeting point for four passenger trains, he said to the fireman: "We will run this next water station and go to K. for water." He said: "That's good, and we will have about ten inches of water in the tank when we get there." As this fireman had not looked into the tank since last taking water, I wondered how he knew just how much water would be in the tank on arrival at K. (this being an unusual run he had never before made with such a heavy train). In conversation with him he explained why he could tell without looking into the tank. He stated that he knew from the uniform maximum steam pressure, the very light fuel consumption and the quarter turn of the water valve to injector that the engine was not using much water.

The mechanically fired locomotive is quite a factor in educating the fireman not only in the economical firing of the engine, but also enables him to better observe the manner in which the engineer handles the engine. Another fact is that the stoker has a tendency to make the fireman more mechanical. He feels there is a certain amount of responsibility attached to the operation of the stoker. Therefore he gives more attention and thought to the locomotive as a whole than when on the hand-fired engine.

From a safety standpoint the mechanically fired locomotive has the advantage of two men being constantly on the lookout. Inquiry of one railroad brought out the fact that there was no record of any mechanically fired locomotive running by a block or red board. This in itself is of more value than appears on the face. One bad rear end collision will pay for any number of stokers.

The mechanically fired locomotive will in our opinion enable railroads to employ high-class young men for the position of fireman, who in time will become high-class engineers, and in the end the railroads will profit by it with increased tonnage, reduction of number of hours on the line, reduced fuel consumption and less fire-box and boiler maintenance expense. Mechanically fired locomotives make contented jobs for the engine crew, and a contented engine crew is a valuable asset to the railroad.

The report was signed by Jas. Fahey, Nashville, Chattanooga & St. Louis, chairman; F. P. Roesch, Standard Stoker Company; A. N. Wilsie, Locomotive Stoker Company; H. Von Erickson, Great Northern; W. T. Hanna; N. Shurie, and R. Hammond, New York, New Haven & Hartford.

Discussion

The discussion of this paper indicated plainly the opinion of the majority of the members that mechanical firing enables a higher grade of men to be hired for the position of firemen and consequently provides a better source from which to obtain competent enginemen. The fireman on the stoker-fired engine reaches home after a trip in such physical condition that, with sufficient ambition, he can study effectively. In addition while on the locomotive he is enabled to study the engineman's method of handling locomotives much more than formerly. An important safety feature is provided in that the fireman has time to assist in watching for signals to a much greater extent than when compelled to fire locomotives by hand.

In general, mechanical stokers are applied on locomotives of 50,000 lb. tractive effort or greater, which leaves out many of the Pacific type. The safety feature, however, may in some cases justify application of stokers to locomotives which as far as size is concerned could be hand-fired effectively.

Oil Burning Improvement on Locomotives

There are now 45 railroads in the United States making use of oil fuel in locomotives to a greater or less extent. Last year these railroads used 57,600,000 barrels of oil valued at approximately $7,800,000.

With this widespread use of oil as fuel on our railroads, not only the most capable officers and employees of the railroads themselves but the best combustion and designing en-

gineers in the world have devoted their best efforts in producing the modern oil-burning locomotive. To say that it is not highly efficient would be to ignore the results of thousands of tests which plainly show that it compares very favorably with the most modern central stations and that it does so under serious handicaps. But none of us is satisfied, nor do we think perfection has been reached.

How to improve the burning of oil in locomotives brings us face to face with the problem of securing complete combustion of a large amount of oil in a small space and during a very limited time. From the time a drop of oil leaves the burner tip until it is completely atomized, consumed and has reached the flue-sheet less than one second has elapsed.

There are four conditions ever present that must be met before complete combustion of oil can take place; first, the oil must be properly atomized; second, we must have the proper amount of air; third, we must have the proper temperature in the fire-box; fourth, we must have a sufficient length of time for the thorough mixing of oxygen and gases and to complete combustion before they reach the flue-sheet.

Burner

That much thought has been given to the construction and design of oil burners is shown by the fact that more than 3,000 burners have been covered by patents in some form or other; yet the few steam atomizing burners in most general use on the largest oil-burning railroads are of simple construction, have stood the test under keen competition, and some of them are now unprotected, as the original patents have long since expired.

Many attempts have been made to introduce mechanical atomizing burners on locomotives, and no one doubts but what a more complete and thoroughly atomized oil spray may be obtained through such a burner, but the chief difficulty encountered is in the range required. A 2-10-2 type locomotive under maximum working conditions consumes 550 gal. or 4,400 lb. of oil an hour. The ordinary mechanical atomizing burner will deliver 300 gal. or 2,400 lb. of oil an hour, which would mean two such burners. The problem therefore appears to be one of increasing the capacity of the mechanical atomizing burner rather than installing more than one burner.

This subject is now receiving careful study at home through a trial installation of a mechanical atomizing burner on a switching locomotive of an eastern railroad. The burner being tested is the wide-range mechanical atomizing type of the Peabody Engineering Corporation. This burner was installed October, 1923, and no difficulties have so far been encountered in maintaining maximum steam pressure; neither is it necessary to clean soot from flues, as the oil is so completely consumed that no soot is deposited.

A very interesting experiment with mechanical atomizing burners on locomotives was conducted recently on one of the large French railroads. These tests were highly satisfactory and they now have 37 locomotives so equipped. One burner is capable of taking care of a French locomotive, but their power is somewhat smaller than ours. This burner is the Whitehead Ray rotary type, an American product. A dependable supply of oil for locomotive use is at present an unsolved problem with the French railroads.

That possibilities exist through application of mechanical atomizing burners for economy in the amount of steam used for atomization (the ordinary steam atomizer-burner uses from 2 per cent to 4 per cent of the total output of steam) and for reducing the amount of fuel that is required by improving combustion, no one doubts, but there are some difficulties yet to be surmounted.

Steam is the spraying agent now in use to atomize oil, although certain people recommend the use of air. If you should experiment with air for atomizing, don't rob the compressor, for 100-car trains are the prevailing style and they keep the air pump fairly busy. From a mechanical point of view a cubic foot of compressed air would break up as much oil as a cubic foot of steam if both were at the same pressure. But taking the mechanical efficiency of the air compressor into account, a cubic foot of compressed air costs nearly twice as much as a cubic foot of steam at the same pressure. What is desired is that oil should be at the highest practicable temperature as close as possible to the burner tip. The use of compressed air as an atomizing agent tends to lower the temperature at the burner tip, while the use of steam as an atomizing agent tends to raise the temperature at the burner tip. It should be noted that this increased temperature is accomplished in two ways: First, by heat transfer due to coming in contact with steam, and, second, by absorbing heat given off by steam during sudden expansion. The dryer the steam used for atomizing the oil the better the results. Superheated steam therefore has the preference.

Burner Location

The standard location of the burner is in the front of the fire-box below the flue-sheet, the oil being sprayed toward the back end of the fire-box, where the flash-wall is located to deflect the flame, which then turns and travels again about the full length of the fire-box to the flue-sheet. This location was adopted after numerous tests with the burner in the back end of the fire-box, also with two burners, one in the front end and one in the back end of the fire-box. Of the mechanical burners mentioned above the one being tested on a switch engine is in the back end of the fire-box, while those on French locomotives are in the front end in the same location as our burners.

If it were possible to reduce the distance between the burner tip and the point of ignition, a much longer time would be allowed to complete combustion, the gases would have more time to give off their heat and the advantage of longer flame travel would be obtained.

Pyrometer tests show that the temperature of hot gases entering the tubes drops to about 1,300 or 1,400 deg. F. within 18 in. after coming in contact with evaporating surfaces, which is about the lowest temperature at which complete combustion takes place. Where combustion is not completed by the time the burning gases enter the tubes it is a known fact that they are chilled below the igniting point and deposit carbon on the tubes in the form of soot.

A series of tests were made in the fall of 1919 and the present standard of front end burner without an arch or arch tubes was found to be the best arrangement and produced the highest efficiency.

During the past few months a test has been in progress with thermic syphons on 2-10-2 type locomotives with front end burners to determine if any economies are possible from their use, and since these syphons are in the same relative position as arches or arch tubes it revives interest in the subject and makes one wonder if there would not be a possible field for some economy from further tests with arches in view of the fact they are part of the standard equipment on coal-burning locomotives. Three factors were against the use of arches in the tests previously conducted, namely difficulty in connection with maintenance of arch and arch tubes and the expense and trouble caused by pieces of broken brick falling down in the path of the flame, sometimes causing engine failures, difficulty in sanding flues, especially the lower ones which were behind the arch, and the impingement of flame against the crown-sheet where the arch ended. With the advent of larger power and combustion chambers in fire-boxes we are confronted with somewhat different conditions. Have not the arches been improved through stronger construction and the use of better brick and other material? Will not the mechanical steam soot blower enable us to reach all the flues? The third feature of impingement

is not so easy to overcome and may prove the stumbling block, although improvements in combustion through the mechanical burner may help out in some measure.

Air Openings

The proper location and the correct size of air openings in the fire-pan are of utmost importance. A safe rule is for air openings to be seven times the area of the cylinder. Sufficient air should be admitted around the burner to prevent it from becoming overheated. Too much air admitted around or under the burner unless proper damper control is provided may result in chilling the lower flues, as the air takes the line of least resistance and goes up the front brick wall and into these flues on its way to the stack. Leaky flues are often the result.

Admitting the major portion of air to the fire-box through a flash-hole varying in size from 8 in. by 10 in. to 13 in. by 20 in. and located from 9 in. to 18 in. in front of the flash-wall and a 2-in. by 35-in. opening in the hooded fire-door is one practice on Southern Pacific Lines. The air openings are approximately as follows: Flash-hole 25 per cent, burner openings, 5 per cent, door damper 5 per cent of the minimum area of tubes allowing for units. This is what is known as the vertical draft having the hooded door as against a solid door with a 5-in. circular opening used in sanding flues.

The horizontal draft differs slightly in that it admits the air through small openings in the front of fire-pan around the burner and through the hooded door. Each of these methods are in general use on the Southern Pacific.

The draft-pan opening or flash-hole is also used by other oil-burning roads, but they also have a number of round openings along the side of the fire-pan over which an adjustable slide may be drawn by lever control from the cab to regulate the amount of air.

It is well known that an appreciable amount of heat is lost through radiation from the outside of the boiler, losses being greatest from the outside side-sheets of the fire-box. Engineers today are recognizing the fact that pre-heating the air means fuel economy. It may be possible to use at least part of the heat now lost through radiation for pre-heating air to the fire-box. How this can be done is a matter for development, possibly through the use of easily removable ventilating air ducts attached to the outside of the boiler, conveying the heated air to the present air intakes to the fire-box.

Dampers

The device which regulates the amount of air entering the fire-box plays no small part in maintenance cost and fuel economy. The usual damper control is by rod or chain connection from the cab. On the French locomotives mentioned above a worm gear control on the rod connection from the cab is now in use and gives very accurate adjustment of the damper.

At the present time there are two styles of balanced dampers being tested on the Southern Pacific, one is a butterfly damper enclosed in an air chute at the front end of the fire-pan and the other is a flapper damper which hangs in closed position over the front end of the fire-pan and is opened by draft when the engine is exhausting. Both are meeting with success, but neither has been in use long enough to pass judgment as to which is better.

The dampers on an oil-burning locomotive are in a location where inspection and maintenance are difficult, which should lead us to perfect a damper which will require the minimum of attention and yet be always serviceable.

Furnace Design

Heating surface of the fire-box is worth five times as much per square foot for evaporative purposes as that of the tubes.

Anthracite coal is burned on the grate. As air is passed through the bed of coal the oxygen and carbon unite, mechanically forming complete combustion within the bed of coals. With bituminous coal the oxygen unites with the fixed carbon as with anthracite coal, forming complete combustion within the bed of coals, but the volatile part of the coal is driven off and must find its oxygen and sufficient temperature to complete combustion in the furnace space above the bed of coals. For practical purposes fuel oil is a 100 per cent volatile coal, because the entire body of oil is sprayed and burned in the furnace space. From the above it is apparent that the greater the percentage of volatile matter the greater the furnace volume required. Therefore fuel oil or gas requires greater furnace volume than any other kind of fuel. When coal is burned the radiant heat from the bed of coals ignites the gases over the bed of coals. With fuel oil there is no bed of coals, therefore sufficient refractory surface must be installed in the fire-box to take the place of the bed of coals and furnish sufficient radiant heat to maintain temperatures high enough to complete combustion. Where there is not sufficient refractory surfaces or where the refractory surface is poorly located, drumming will result.

Some oil-burning authorities never sacrifice a square foot of heating surface in the fire-box wherever possible to secure it, whereas the supporters of carrying the refractory high on the side-sheets claim that the heating surface closely adjacent to the mud-ring is of little value. One thing is certain by the new arrangement, and that is, that engines will not be in the back shop as often by far for new side-sheets with the high refractory setting.

Front End

There has been considerable speculation as to the removal of baffle-plates from superheated locomotives using oil as fuel. One road reports no apparent deterioration of superheater elements, although the baffle-plates were removed from these oil-burning locomotives two years ago. It is the purpose of these baffle-plates to prevent gases from passing through the superheater flues while the engines are being fired up and standing and also to give a more equal distribution of the gases between the upper and lower portions of the evaporating surface and superheating surface. With the baffle-plates removed the natural tendency is for the gases to flow through the top flues where less restriction is offered. On some of the engines which have had the baffle-plates removed a longer downward extension stack has been applied, which in a measure helps to baffle gases passing through the top flues, creating a condition similar to that where baffle-plates were in use. With baffle-plates removed it is much easier to keep the flues clean, as they take sand more readily. It is also easier to fire up engines without forcing and making black smoke. It also means one less item of maintenance. It is no doubt a fact that the removal of baffle-plates from oil-burning locomotives would be more advantageous and that less damage would occur to the superheater elements than on a coal burner.

The report was signed by J. N. Clark, Southern Pacific.

Discussion

In discussion of the paper on oil burning, one member said that he had tried eight different types of burners and that only 5 per cent difference in fuel consumption between the best and the poorest could be discerned. This was in a test of 2,400 miles for each burner. The location, method of connection and height of the burner have an important bearing on oil consumption, however. The consensus of opinion was that the burner should be located from five to eight inches above the floor of the fire pan, the prime essential being the placement of the burner so that the flame is directed properly. A space of approximately five feet should be allowed from the burner to the flash wall for the most desirable results.

Waste—Some Ways to Eliminate It*

The Untimely Reduction of Forces and the Lack of Standardization of Car Parts Results in Enormous Losses

By D. M. Raymond
Car Foreman, Union Pacific, Green River, Wyo.

ONE of the most prolific sources of waste in the mechanical department of a railroad comes from a practice which possibly would least be expected to result in waste. This practice is one followed by practically every railroad, that of reducing mechanical forces during times of business depression. In other words, steps taken to reduce payrolls in an effort to cut down expense, while temporarily effecting an apparent saving, actually result in the eventual expenditure of sums exceeding the amount saved.

Admitting that such a statement appears paradoxical at first glance, it is nevertheless founded upon good and firm reasons.

Let us take the situation from the beginning to the end: First, we have the beginning of the business depression; second, will be the reduction of shop forces, including skilled as well as unskilled mechanics; third, comes the resumption of business; fourth, the enlargement of shop forces. These four points are the governing factors. Analyze them one by one and the real result that follows each individual action will become apparent.

The first point, being outside the province of the shop worker, we will pass over, it being admitted by every person even partially familiar with the subject, that business depressions are evils which cannot always be avoided and must, therefore, be accepted as they come and coped with as well as circumstances permit.

Therefore, we shall pass to the second point. In this item we have debits and credits, which, briefly, are as follows:

Credits—Instantaneous reduction of expenditures.

Debits—(Not instantaneous but accruing). They would be listed somewhat on the order following: Rapid deterioration of equipment and eventual storage of bad order rolling stock.

Since it is only in a complete analysis that the debits can be made to show up against the credits, we will have to let such analysis wait for the following two points, in order to get at the real proposition. Therefore, let us go on to the third point which brings about a demand for equipment as well as a demand for immediate increase in shop forces to restore bad order equipment to service, at the same time keeping present rolling stock in condition. Now, we will see just what happens from the beginning to the end.

Since, as stated above, the actual results of the first and second steps are not instantly discernible, but are dependent upon the third and fourth steps, we can make the point clearer by dealing directly with conditions covered by those last two steps.

A demand for equipment develops. Where is it? Mostly on repair tracks and storage tracks. An easy matter to get cars out of storage, we will admit, but when you come right down to the point you will find that they were not placed in storage until some minor defect, if not a major defect, developed to make them unserviceable. They were not repaired for the reason that a shortage of forces made it impossible to repair them, and because there was no urgent need of the cars. Therefore, the situation you have to meet on the resumption of business, is one calling for the hurried repairs to rolling stock. It is a fair guess that shop forces are not going to be recruited to full strength soon enough to meet all the demands for equipment. Therefore, the ensuing losses due to the inability to get cars into revenue service must be placed as a debit against point two.

There is another point to be taken into consideration. It is the fact that in the recruiting of shop forces men are taken on who are not familiar with practices on the road which employs them. What is the result? However skilled a mechanic may be in his craft, he must lose a considerable amount of time in becoming familiar with local routine, his fellow employees, etc. Nevertheless, because he is a skilled mechanic, he is paid full rate. It is apparent that he is wasting valuable time as compared with an employee who is thoroughly familiar with practices. Therefore, we have another debit to place against point two.

Let us assume that instead of laying off a skilled man we keep him on the payroll during the depression. There would be little saving effected at the time when it would seem to be most needed, but let us look farther and see if in the end his retention would not be justified. For one thing, shop forces would have an opportunity to catch up on all bad order equipment. No cars would be sent to storage for the want of repairs. Such repairs could be made first. Then, when the business revival comes, the equipment is there, ready for instant use—no waiting. Furthermore, the shop forces are not rushed off their feet by demands for equipment over-night when there is little hope of getting the equipment in shape to meet demands for some time—perhaps weeks or months. Neither will the shop forces have to lose valuable time in waste motion getting acquainted and becoming accustomed to practices which would be the case as above mentioned. Instead, they would be in a position to augment their roster by taking on men who need not necessarily be skilled and who, accordingly, would not be drawing high wages. This means another direct saving which should be debited against point two.

Still another good feature in keeping the skilled men at work all the time is in the fact that such men as could be made to feel that no depression would necessitate their separation from the payroll, and this would naturally repay the employer in loyalty as well as increasingly effective work. They would feel that they were actually members of the family. Such a morale is highly desirable in any large organization, particularly on a railroad which depends to such a great extent on public opinion.

While a proponent of the force reduction policy might be inclined to question how skilled forces could be maintained the year round, such a question being natural under present conditions, it must nevertheless be borne in mind that it should never be necessary under the retention policy greatly to augment forces when the rush begins.

The logical conclusion is that by striking an average of the number of skilled employees necessary at given points during the whole year and putting that average on duty for the entire year, the number could easily cope with any condition which might be expected to arise, considering that there would not likely be any condition which always comes under the force reduction plan.

Weigh the two arguments together as carefully as you

*This paper was the second prize award in the competition on the elimination of waste which closed November 15, 1923.

wish. No other conclusion can be drawn than that eventually the retention policy will result in more benefits than the reduction policy. Hence, the statement at the beginning of this article, that the greatest waste on railroads comes from laying off mechanics because of business depressions.

There is still another large waste—one which every railroad man has recognized—particularly the car man. It is the limited scope of standardization of freight car parts. No one familiar with the subject will deny that millions of dollars annually are contributed by the railroads of the United States to the scrap heap because of wrong repairs.

Suppose we take into consideration the item of draft gears alone. Certainly there is no single railroad in the country which carries parts of all draft gears in their entirety. In fact, while they may carry a large portion of the present makes of gears, they do so merely in order to facilitate repairs to foreign equipment, not for their own use except insofar as they are benefited in keeping their repair tracks cleared of foreign per diem earning cars.

Yet there is an enormous amount of capital tied up in these stocks kept on hand. And that amount could be reduced by not less than 50 per cent if plans were effected to standardize equipment throughout the country and do away with unnecessary purchasing, handling and storing of material.

The only persons who would be interested in reading this article undoubtedly would be those who are familiar with car parts and car matters. Such persons are already fully aware of the large waste brought about by the lack of standardization of freight car parts. Therefore, any detailed analysis of the situation would be only useless here. It is enough to point out that with freight cars standardized, it would be unnecessary to hold foreign cars on repair tracks for days at a time awaiting material from owners during which interval they are losing revenue, both for the owner and handler. Or, suppose the handling line should make wrong repairs. It comes to the same thing in the end. It is only a waste; for while the road making wrong repairs may get the car moving, it will eventually have to stand the cost of correction of the wrong repairs, and the car sooner or later goes out of service and becomes a drone instead of a worker during the period when it undergoes correction of wrong repairs.

Of course, it is admitted that the present day practice of using so many different types of car parts is due in some respect to the endeavor to bring out in actual test in service that part which is superior to others of the same type. That is the one good feature about the lack of standardization. However, in view of the present day methods of testing parts in laboratories especially designed for such testing, making it unnecessary to put them in actual road service, it is undoubtedly possible to conduct such tests apart from actual road service until such time as the approved parts are eligible for adoption as a standard for all car owners. In this way no deterrent would be placed in the way of inventive genius.

So, in the above, you have two of the largest wastes in the mechanical department of a railroad. The waste on account of reduction of forces without proper insight into the future and the waste on account of lack of scope in the standardization of car parts.

Suppose the two enormous wastes were such that they could be shown in actual dollars and cents—and insofar as those concerning wrong repairs they could be put in figures to some extent—is there any foreman who has a doubt that such a showing of figures would convince the most skeptically inclined that the adoption of the above ideas would result in a prevention of waste running into millions of dollars annually?

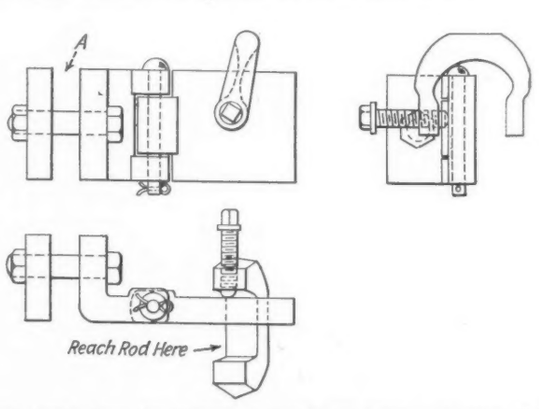
Helpful Suggestions for Setting Valve Gear

Simple Formulas Used to Obtain Correct Alterations for Eccentric Rods and Valve Rods

By H. W. Stowell
Machinist, Santa Fe Shops, Albuquerque, N. M.

IN setting valves on locomotives equipped with the power reverse gear it is necessary to take some precaution to prevent creeping. Some of the older types are provided with a set screw on the reversing crosshead which is very convenient for the valve setter. In types not so equipped it is necessary to clamp the reach rod either by a special clamp as shown in the illustration or by some other arrangement. The clamp is bolted at *A* to the screw reverse frame which binds the reach rod tightly against the hinged portion. This allows the angle iron to fit squarely against the reach rod so that it may be tightened securely without springing it.

Where should the reverse lever be set to square an engine by the port openings? In engine house practice the length of the motion rods is usually tested by trailing the locomotive over and scribing the valve stem to show the port openings. The reverse lever is generally placed in or about the working notch to produce a cut off at approximately 25 per cent. There is a certain position for each different kind of valve gear where the best results will be secured. The manufacturers of the Baker valve gear recommend trailing locomotives equipped with the gear in the 25 per cent cut-off position, which produces an average port opening of 7/16-in. If the Baker gear is run over in this manner and then placed in the corner notch, some startling distortions will be observed. With the valve square in the hooked-up position the valve rods and eccentric rods will show out as much as ¼-in. when the lever is placed in the corner notch.



Hinged Angle Iron for Clamping Reach Rod When Setting Valves

If the reverse yoke is placed about three inches from its neutral or out position, a 7/16-in. port opening will be produced, and this gear should not be squared in any other posi-

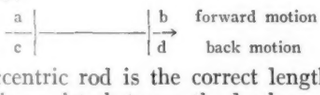
tion by trailing. The length of the auxiliary reach rods is something that should be looked after before running the locomotive over. When the tumbling shaft arms are plumb, the gear reach rods on both sides should be adjusted, if necessary, to maintain the dimensions furnished by the manufacturer. It will seldom be necessary to make any further change to correct an error in the total travel.

The exact cut off which will give the best results in squaring valves by trailing is not so particular with the Walschaert gear, but good results are obtained by setting the reverse lever so the center of the link block pin is from 2½-in. to 3-in. from the center of the link trunnion. This position will produce a 7/16-in. to a ⅝-in. average port opening. Engines equipped with this gear will not be square in every reverse lever position but if square in the hooked-up position, they will not show out more than ⅛-in. when the reverse lever is in the corner notch.

Figuring Eccentric and Valve Rod Changes

Most books on valve gear devote several pages to the method used to figure eccentric and valve rod changes on the Walshaert and Baker gears. Arbitrary rules are set down which often prove a stumbling block to apprentices and others because no clear reason is given. I have found the following formulas very handy for quickly obtaining the correct alteration for these rods:

Let *a, b, c* and *d,* represent the lead marks or port openings when setting valves of this kind by trailing. Adopting the conventional form for representing the condition of the valve gear and letting the arrow indicate the front of the engine, we have:



When the eccentric rod is the correct length we know the following relation exists between the leads:

$$a - b = c - d$$

Let x represent the valve movement produced by the eccentric rod error and we have the equation:

$$a + x - (b - x) = c - x - (d + x)$$

Solving we have equation 1:

$$x = \frac{b + c - d - a}{4}$$

This is the amount the valve must be moved. To obtain the actual eccentric rod change multiply x by the ratio of the gear, which varies with different reverse lever positions. If x is a positive number, lengthen the eccentric rod; if negative, shorten it. If the travel marks fall inside the port marks, carry the amount blind as a negative number.

The approximate ratio used to figure the eccentric rod change may be found by dividing the valve travel (at the cut-off where the locomotive trailed) by the throw of the eccentric crank. With a short cut-off the ratio will be a little greater than indicated by this method, for the valve is partly under the influence of the combination lever at the point of maximum port opening. This ratio may be obtained by trial by dropping the front end of the eccentric rod, tramming from the link heel hole center to some stationary point, also tramming the valve rod, and then moving the link, noting the ratio between the line separation at the link heel and the valve stem. In full gear the point of maximum port opening occurs when the combination lever is in the vertical or out position, and the valve travel divided by the eccentric throw is the exact ratio of the gear.

A formula may be also used to figure the valve rod change:

Let *a, b, c* and *d,* represent the leads as above.

Let x represent the valve rod change. When the valve rod is the correct length we know that:

$$a - b = d - c$$

An eccentric rod error effects opposite motions in opposite directions. We may now set up the equation:

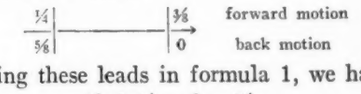
$$a + x - (b - x) = d - x - (c + x)$$

Solving we have equation 2:

$$x = \frac{b - a + d - c}{4}$$

As before, if x is positive lengthen the valve rod, if negative shorten it.

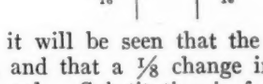
To illustrate how these formulas may be used suppose the following condition exists:



Substituting these leads in formula 1, we have:

$$\frac{⅜ + ⅝ - 0 - ¼}{4} = \frac{3}{16}$$

Since the 3/16 is a positive number, lengthen the eccentric rod 3/16 times R, the ratio of the gear. This proves, for after the change is made the example becomes:



By inspection it will be seen that the eccentric rod is the correct length, and that a ⅛ change in the valve rod will square the example. Substituting in formula 2, we have:

$$\frac{⅜ - ¼ + 0 - ⅝}{4} = - ⅛$$

This indicates that the valve rod should be shortened ⅛-in.

The use of these formulas is a help to the beginner in valve setting as they indicate the direction of the change as well as the amount. As given, they are applicable to the Walshaert gear or Baker gear when direct in the forward motion. For an outside admission Baker gear the formulas would need a slight change.

In the Walshaert gear the hangers may be checked by finding the still valve position. Here the question of ratio comes up again. It varies with different designs but is usually between 1½ and 2 to 1. If a locomotive is carefully assembled large link hanger changes will be avoided.

Setting cranks to a specified throw seems to give as good results as the more correct method of taking the dead centers, etc., but in using this shorter method the length of the crank should be checked. The throw of the crank may be taken with a long tram on the cylinder or by using a board clamped to the guide yoke. If the center of the crank falls over the hub of the wheel quite accurate results may be secured by scribing a circle on the hub with a diameter equal to the specified throw.

The center of the eccentric crank pin is adjusted to the circle on the hub by the use of a square and scale. In renewing a crank the original setting may be maintained by tramming from the pin center to some stationary point and then adjusting the new crank until it trams the same.

Determining Lead for Stevenson Link Motion

If it is necessary to alter the lead of a Stevenson link motion confusion will be avoided by remembering the following rule: To increase the lead turn the eccentric on the axle in the direction the locomotive runs, that is, to increase the lead, the back-up eccentrics should be turned on the axle in the direction the wheels turn when running backwards, and the forward motion eccentrics in the direction of rotation when the locomotive is running forward. This holds good for any arrangement for admission or motion.

The proper position to trail an engine equipped with the Stevenson link motion is in the full travel or corner notch. In any other reverse lever position both blades effect the position of the valve and the error shown is the resultant of the error of both blades or the error of one blade partly neutralized by the other. It sometimes may be desirable to try the engine in the short cut-off and make any slight changes necessary but as a rule a locomotive with the Stevenson gear squared in the corner notch will be square at any cut-off. This cannot be said of the modern types.

Give Special Credit to Harder Working Boys*

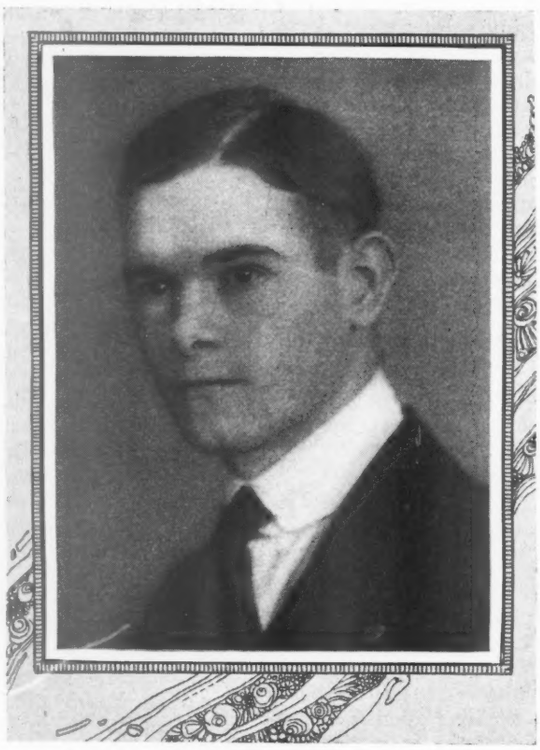
Incentives Are Suggested for Inspiring and Maintaining the Interest and Enthusiasm of the Apprentices

By John M. Wylie
Boiler Maker Apprentice, Erie Railroad

THE young men who usually decide to learn a trade are those whose parents are financially unable to permit them to continue their education or those who, unwilling to study, choose a trade with the mistaken idea that study is unnecessary in that occupation. While the first are apt to begin with a handicap due to lack of education, they are likely to advance more rapidly than those who are too lazy to take advantage of study where it is offered. The reason for lack of advancement is usually due to the fact that the latter type are in the majority.

Various railroad systems at one time or another have established what is known as apprentice schools. These schools are usually equipped in an up-to-date manner. They are headed by competent instructors who, in most cases, have both practical and technical knowledge and conduct classes in mechanical drawing, arithmetic, the principles of plane and solid geometry, and practical and theoretical mechanics pertaining to the trade.

In a shop where there are many apprentices, there is a great deal of work for the instructor thoroughly to familiarize the young men with these subjects. There should be given at least four continuous hours of instruction per week. The instructor can usually pick out the boys who are eager and willing to receive a better education. It is only fair that they should be given longer school hours as compensation.



John M. Wylie

It is difficult to obtain a man who has a thorough practical knowledge of all the trades in railroad shops. If the instructor is assisted by competent men, chosen from different departments, it will give the boys a broader knowledge of the trade. When a difficult or special job is undertaken in the shop the foreman should have an apprentice working with the mechanics.

Apprentices should be transferred from one class of work to another every three months, the instructor, not the foreman, having the authority to do this. It is only natural for the foreman to keep an apprentice on the work he is especially good at, but this is not fair to the boys.

During business slumps as many apprentices as possible should be retained. When an apprentice is serving his time on the basis of the number of days of work per year, and is laid off a great many days a year due to business depressions, at the end of the year he may be as far as three months behind his required time. If this happened for four years in succession the apprentice would be practically losing a year's time, or serving a term of five years. He would naturally lose interest and seek another position with steadier work. Other boys seeing these things turn towards other positions.

The only way to make a thorough mechanic is to keep him interested in his work at all times. Give the young men who are eager to better themselves something to look forward to. The apprentices giving their utmost attention to their work, both practical and technical, should be compensated in some way. If an apprentice is particularly good in the trade he chooses to learn, shift him to another department and then to another. By doing this he will get a general knowledge which will later fit him to become not only a foreman but a general foreman. A short trip to some larger shop given semi-annually to apprentices whose marks are above a certain average for that period gives the apprentice something to work hard for. You will find those who have the passing marks are not doing it for the trip, but for the experience they will gain by seeing how the work is done in various shops. The boys who are unfortunate will try just that much harder to pass the next time.

Some people claim that the public libraries are the greatest institutions in the world. The apprentice schools should have a library, not only equipped with mechanical books, but with English and commercial books as well; also mechanical magazines. This library should be for the use of the apprentices. There are many men in business today who if they have to write a business letter rely upon their stenographers to punctuate, spell difficult words and also word the letters properly. The apprentice should be taught these things to fit him for high positions.

AN ATTRACTIVE BULLETIN board is a vital factor in safety. Many accidents are preventable by education. Safety bulletins should be prominently displayed to get best results. Committeemen should watch the safety bulletin boards and call the attention of others to them. Where they are found untidy and to contain obsolete bulletins report should be made to the committee chairman.—*A. C. L. Circular.*

* Awarded honorable mention in the Apprentice Competition which closed September, 1923. The prize and other contributions which have thus far been published will be found in the *Railway Mechanical Engineer* for January, 1924, page 11; February, page 86; March, page 153 and April, page 213.

New Development of the Gas-Electric Car

The Electric Transmission Permits a High Acceleration and Torque at Low Speeds

ABOUT three years ago the General Electric Company and the Electro Motive Company, Cleveland, Ohio, began the development of a new type of gas-electric motor car. The first cars of this type have just been delivered, one each to the Chicago Great Western and the Northern Pacific. The cars are driven by a 175-hp. gasoline motor, direct connected to a 110-kw. 700-volt generator which supplies power to two railway motors mounted on the power truck. They weigh approximately 70,000 lb. each, are 57 ft. 4 in. long over the body, by 9 ft. 9⅜ in. over the belt rail, and have a maximum seating capacity in the passenger compartment of 59 persons, with 72 sq. ft. of floor space in the baggage compartment. The seats on one side are 54 in. long and on the other side 37 in. long, seating three and two persons per seat, respectively. The aisle clears 22 in. wide.

The Gas-Electric Motor Car Developed by the Electro-Motive Company, Cleveland, Ohio, Has a Seating Capacity of 59 Persons

Construction of Car Bodies

The car bodies and trucks were built by the St. Louis Car Company. The car bodies are of steel construction with an underframe, the design of which is considered sufficiently rigid to withstand the shocks and buffing strains caused by occasional impacts with heavy standard equipment. They are equipped with single windows, but the frames are designed to receive additional storm windows. The floors are double with 1-in. hair felt insulation between. The side walls are similarly insulated up to the height of the belt rail, behind the letter board and under the roof. The entire design conforms closely to steam railway practice.

The car body is divided into four sections. At the front is the engine compartment, which is 8 ft. long. This contains the engine-generator set, the radiator and cooling fan, the air compressor and the operator's station, with the necessary gages and controls. Behind this are, in their order, the baggage and passenger compartments. At the rear is a vestibule with side door entrances, which is 6 ft. 3 in. long. This contains the toilet.

Description of the Power Truck

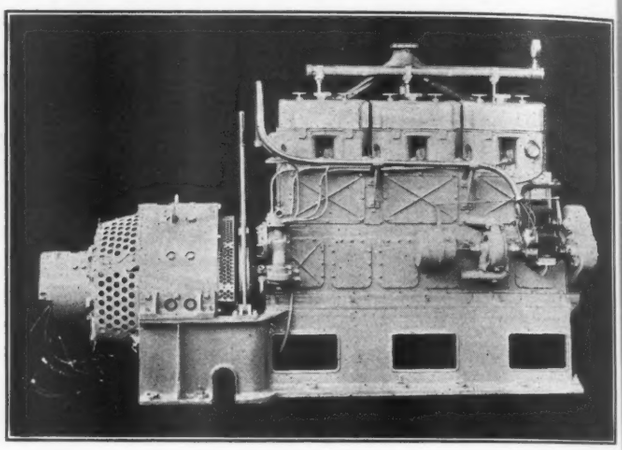
The power truck is a high-speed electric railway type, built with M. C. B. journals and bearings and equipped with

two 105-hp. General Electric railway motors. This truck carries a load of 41,000 lb. at the rail. The cars have sufficient power to pull a standard 30-ton coach and make schedule speed in average branch line service. The maximum speed for which the car is designed to run on level grade is 50 miles per hour. Operating at this maximum speed under level grade conditions and making stops of one minute duration averaging eight miles apart, the maximum average schedule speed of which it is capable is 40.2 miles per hour. On the basis of the same conditions as to the frequency and duration of stops, the maximum average schedule speed decreases as the grade increases, to 22.8 miles an hour on a 2 per cent ascending grade.

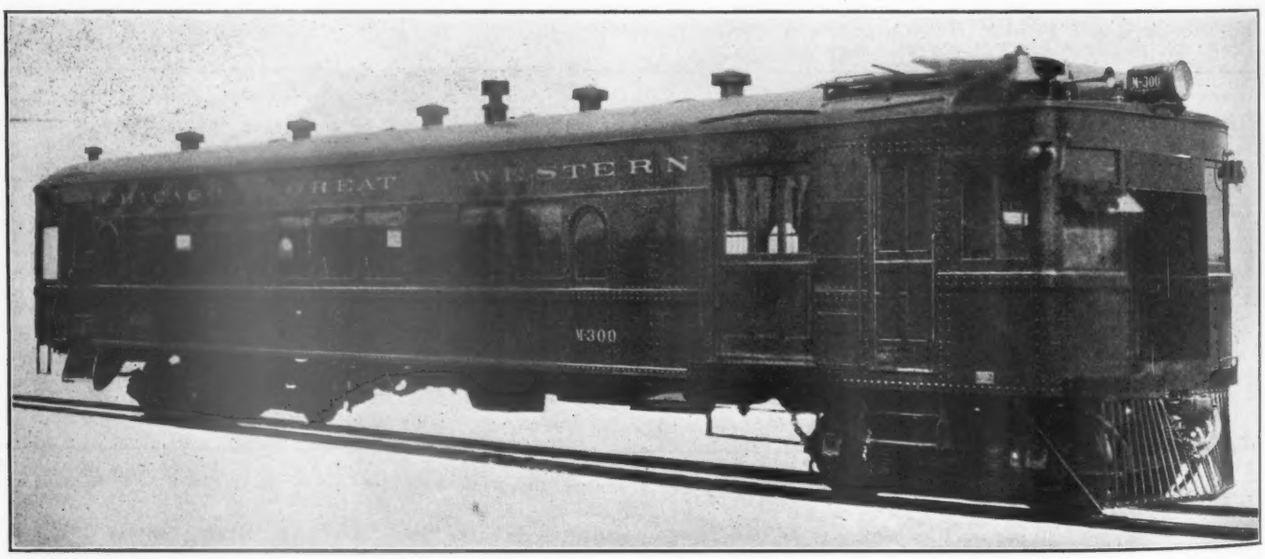
Before work was started on the car, an extensive survey was made to determine, first, the size in greatest demand and, second, the performance requirements. This survey indicated quite clearly that while there was a demand for cars of various sizes, a car seating 55 to 60 passengers with 75 to 100 sq. ft. of baggage space and with sufficient power to pull a 30-ton standard coach over grades of 1½ to 2 per cent, making the average branch line schedule, came the nearest to meeting most motor car requirements. Additional requirements which it was found should be met are a high rate of acceleration and provision for double end control.

The General Electric Company already had built more than 90 gas-electric motor cars from 1908 to 1912, some of which have passed the million mile mark in service and are said still to be showing remarkable operating economy. The problem, therefore, was to develop a new car around the old. Great strides have been made in the development of the gas engine and in electric practice since the original gas-electric cars were designed, and the experience with the old cars was also invaluable.

The survey indicated that the car should not exceed a light weight of 35 tons and, furthermore, that it should be equipped with a railway type engine rather than an automotive, stationary or marine type, as these all have characteristics not suited to railway service. The Winton Engine Works, Cleveland, Ohio, co-operated in the new development and a railway type gas engine was designed around a marine type which has been in successful service for years. This engine has six cylinders of 7 in. bore by 8 in. stroke, with overhead valves and develops 175 hp. at 1,000 r.p.m. It is of rugged construction having a 4-in. crank shaft supported in seven main bearings carried in the lower half of the engine base, thus forming a firm foundation for the revolving and reciprocating parts. The cylinders are built up of a special grey iron water jacket cast in one piece, with cylinder sleeves of semi-steel inserted. The cylinder heads, which are cast in pairs, contain all intake and exhaust passages as well as the valve seats. This entire cylinder and cylinder head assembly is bolted to the upper half of the aluminum crank case. In the design of the engine the problem of its maintenance on the railroad has been carefully taken into consideration. All working parts have been made accessible and the engine is so mounted that any assembly or part of it may be repaired without disturbing the auxiliary apparatus. United States standard threads and bolt sizes have been used throughout.



The 175-hp. Gas Engine-Generator Unit Which Is Placed Transversely Over the Forward Truck Bolster

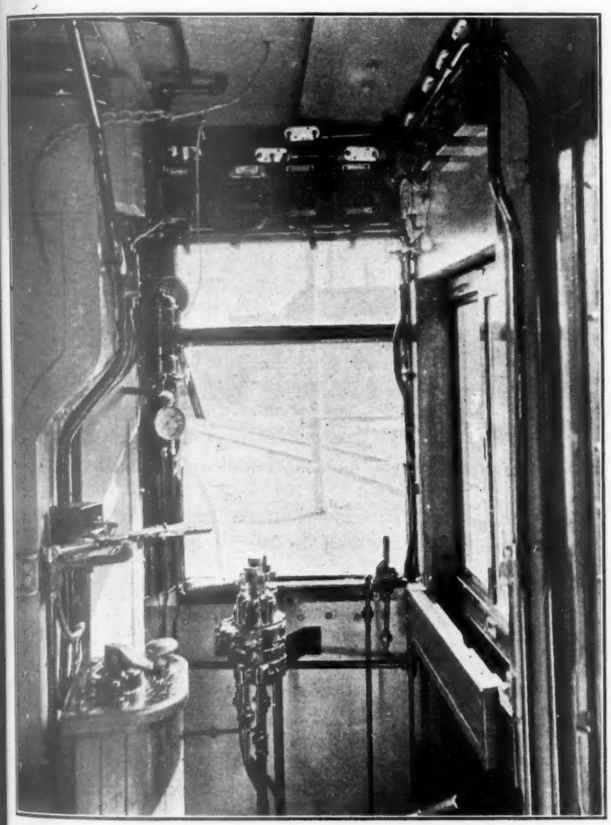


Air Is Drawn Through the Radiator by An Electric Motor-Driven Fan Controlled by a Thermostatic Governor

Since the power of the engine is transmitted electrically, the location of the engine and generator is not fixed by the requirements of transmission. In this car, instead of being located along the longitudinal center line of the car at the forward end of the engine room, the engine and generator unit are located transversely directly over the center of the truck at the rear of the engine room. The body bolster for the forward truck is designed to form the engine foundation. The operation of the car is controlled by what is

termed locomotive control, embodying field control of the generator and throttle control of the engine. The apparatus consists of a series-parallel control with forward, backward and neutral positions, in any one of which a wide range of speed control is available by the locomotive type throttle directly connected to the engine carbureter. No automatic mechanism is involved in this type of control and a locomotive engineer has no difficulty in learning to control the car successfully after a few minutes' practice.

The electric transmission permits a high acceleration and torque at low speeds and permits of operation in both directions with equal performance. The engine speed has no direct relation to the car speed and hence the maximum power of the engine can be utilized at low car speed under severe operating conditions while, on the other hand, a high car speed may be obtained with a low engine speed when low



Operator's Compartment Showing the Control Apparatus

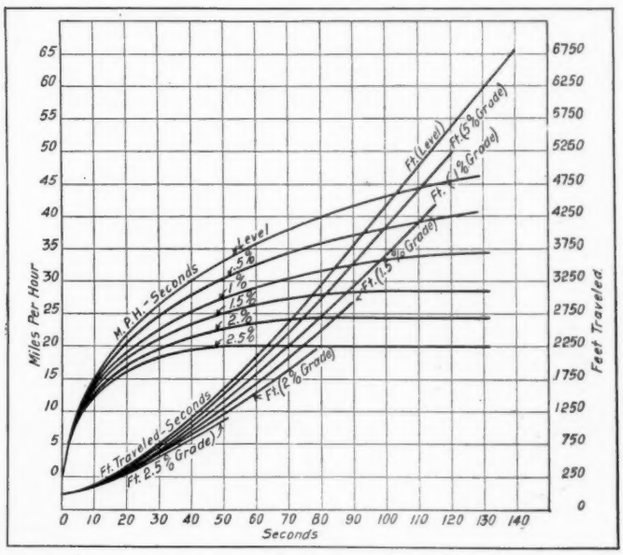
power output is required, thus tending to promote fuel economy and low engine maintenance.

Methods of Engine Control

Three methods of starting the engine are available. A 32-volt starting motor, drawing current from a storage battery, engages the fly wheel. There is also a compressed air starting device which supplies air from the main reservoir of the brake system through a distributor on the cam shaft to each of the cylinders. A standard car hose connection is fitted to the main reservoir pipe so that air may be drawn from any outside source available in emergencies. An effective hand cranking device is also supplied which may be operated with ease and without danger to the operator.

The engine cooling system includes a radiator of ample size which is mounted in the front end of the car, air being drawn through it by an electric motor-driven fan controlled by a thermostatic governor. The radiator is equipped with a manually controlled shutter so that with the variable speed fan and a conveniently located engine temperature gage, a uniform engine temperature, irrespective of atmospheric conditions, may readily be maintained. A convenient connection between the hot water car heating system and the engine cooling system is provided to keep the engine and radiator warm and from freezing when the car must be tied up where there are no terminal facilities. A 32-volt storage battery provides current for car lighting, generator excitation and motor cranking. This battery is charged by a 1½-kw., 32-volt generator mounted on the main generator shaft and enclosed in the same case.

The Chicago Great Western car was operated from the plant of the St. Louis Car Company, St. Louis, Mo., to Chicago, over the line of the Chicago & Alton. At Granite City, Ill., the car picked up a train crew and caboose which weighed 36,000 lb., and, with this load, was able to make passenger train schedule time over the Alton hill with its 1.4 per cent grade. The caboose was cut off at Springfield, Ill., and the car continued on to Chicago light.



Calculated Time-Speed and Time-Distance Curves for the New Gas-Electric Car

The average schedule time from Bloomington, Ill., to Chicago was 43 miles an hour and the average gas consumption for the entire trip was 4 miles per gallon. On the trip two operators handled the car, neither of whom had had any previous experience with it. For the first half of the trip a member of the Electro-Motive Company organization handled the car and on the last half of the trip a representative of the Chicago Great Western took charge and operated the car.

One of the illustrations shows a theoretical time-speed distance curve calculated for these cars. Such tests as have so far been made indicate considerable improvement on what is shown in the diagram. One acceleration test included starting the engine and getting the car under way to a speed of 30 miles an hour in 33 sec.

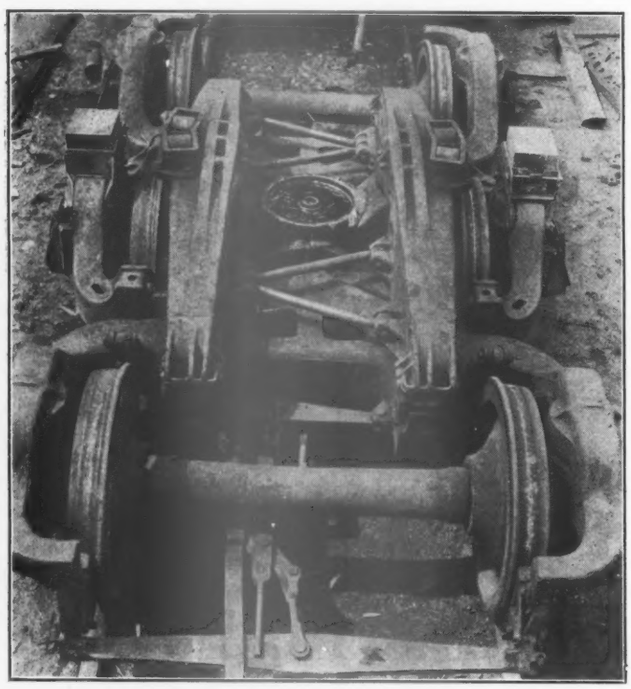
Burlington Dismantles Cars at Eola—A Correction

In the table on the Cost of Dismantling Ten Steel Gondolas at the Eola Reclamation Plant of the Chicago, Burlington & Quincy on page 497 of the August issue of the *Railway Mechanical Engineer*, the value of good material reclaimed as given under the heading "Credits," is $152. This should have been $1,152.

The Boyden Six-Wheel Co-ordinating Truck

Improved Design Eliminates Excessive Swaying and Reduces Maintenance Expense

THE Boyden Steel Corporation, Baltimore, Md., has recently completed a number of tests on a set of demonstration six-wheel trucks of its co-ordinating type. These trucks, in which are embodied a number of improvements over those described in the May, 1923, issue of the *Railway Mechanical Engineer*, were placed under a Virginian railway gondola car of 120 tons capacity. This car was placed in service last May and was in continuous use since that time for carrying coal from the Pocahontas fields in West Virginia to tidewater at Sewells Point, Va.



Top View of the Co-ordinating Six-Wheel Truck

The improved truck, which is known as type C-2-S, is the result of development work initiated by George A. Boyden and consummated by the present Boyden organization. Tests were first made on a full sized truck at the Camden Iron Works, Camden, N. J., to determine its action in passing around various curves. This truck, which was intended for a 120-ton capacity freight car, weighed 22,000 lb., but by making a number of modifications in the design, the weight was reduced to 19,600 lb. Trucks of this type were placed under a 100-ton capacity coal car belonging to the Chesapeake & Ohio, and tests were made in 1920 and 1921 at the plant of the Cambria Steel Company, Johnstown, Pa. These tests resulted in further improvements and a third design was tested out over the Baltimore and Cumberland divisions of the Baltimore & Ohio. A brief account of these tests is also included in the article in the *Railway Mechanical Engineer* which described the earlier model.

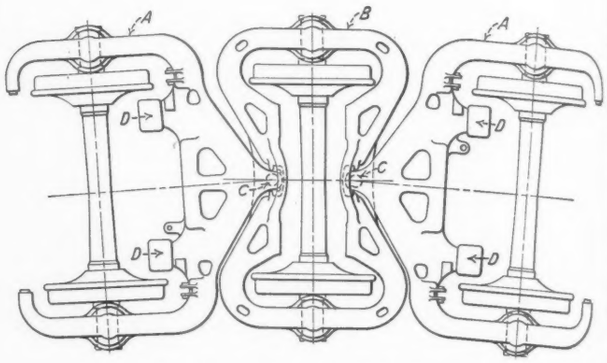


Fig. 1—Plan View, Showing the Frame Construction

Purpose Is to Reduce Curve Resistance

The purpose of the Boyden co-ordinating truck is to reduce curve resistance and to permit greater vertical flexibility. This is accomplished by a construction which permits the wheels and axles to assume their normal relation with the track under all conditions.

Fig. 1 shows a plain view of the understructure of this truck. The two end frames *A*, to which the end wheels are applied through a pedestal type spring supporting journal boxes, carry the bolster reactions to a center frame *B* through a ball and socket joint *C*, located on the longitudinal center line of the truck. The bolster reactions are transmitted first to the end frames *A* at the points *D*. The longi-

Gondola Car of 120 Tons Capacity Used for Testing the Boyden Co-ordinating Six-Wheel Truck

tudinal location of the bolster reaction, points *D*, is such that equal loads are carried on the three axles. It will also be noted that the end frames *A*, which are integral castings, have a three-point support.

Fig. 2 shows an inverted plan of the articulated bolster. Rockers of manganese steel are interposed between the reaction points *D* of the bolster and those of the end frames *A* in order to eliminate friction.

The bolster, composed of three main members, is so designed as to allow maximum vertical flexibility, combined with horizontal rigidity, which prevents longitudinal displacement of the two parallel beams with respect to each

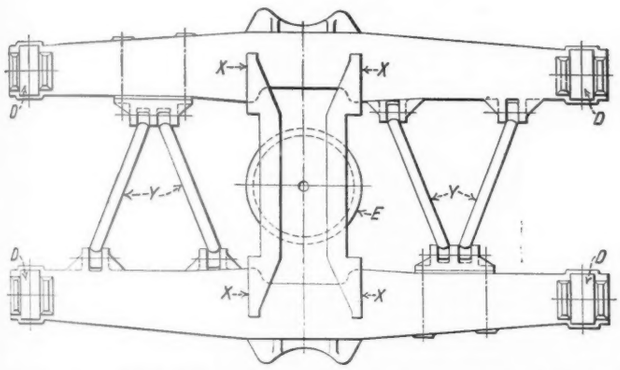
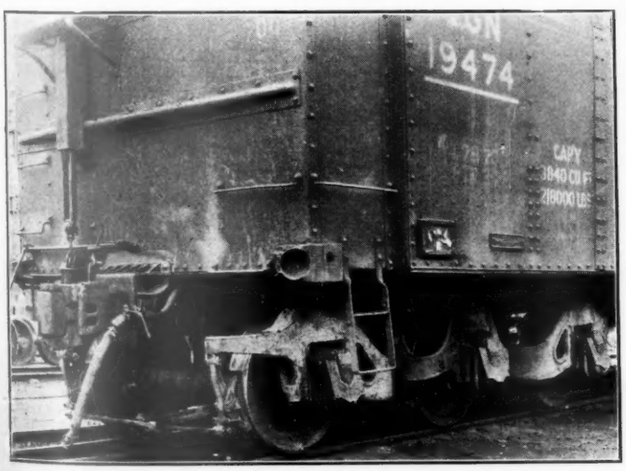


Fig. 2—Triangulated Ties Hinged at the End Prevents Longitudinal Displacement of the Parallel Bolster Beams

other. This condition is secured by use of triangulated ties hinged at their ends to the longitudinal beams by means of the common I-bar construction.

The center bearing bridge *E* carries the center plate load of the car. This member projects vertically downward and straddles the center axle. In passing through the center frame *B*, the parallel surfaces *X* of the bridge are located with a minimum clearance between these and similar sur-



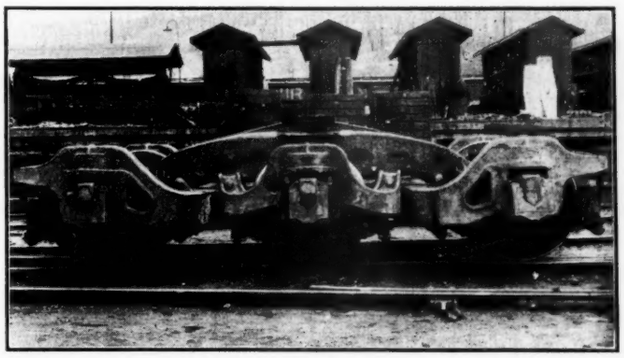
All Parts of the Truck Are Designed with the View of Facilitating Inspection

faces on the center frame *B*. Thus it will be seen that the transverse axis of center frame *B* is maintained at right angles to the longitudinal axis of the bolster, as well as to the track. When on a curve the center wheels are offset with respect to the end wheels; a transverse movement must, therefore, be provided for of the center frame. This is permitted by sliding the relative surfaces *X* of the center frame and bolster bridges and is limited only by the contact of the bridge *E* with the center wheel. Sufficient clearance at this point is provided for the trucks to negotiate a curve with a 65-ft. radius.

New Design Includes Additional Features

An interesting feature aimed to eliminate excessive swaying of the car has been incorporated in this design. It will be noted in Fig. 1 that the center wheels receive equal loading under all conditions of equal or unequal bolster loading on account of the midway location of the load reaction points *C* on the center frame *B*. Thus the center wheels may be loaded in excess of their normal static load, or equal in amount to the loading of the end wheels under moving car conditions.

It will be noted in the illustration showing a top view of the truck that car snubbing blocks are applied over the springs of the center journal. These blocks are not used on the production design, but are arranged separable for test purposes. The top surfaces of the blocks are at a lower elevation than the top surfaces of the side bearing rollers. When the leading or trailing wheels pass over a depression or low track joint, they permit the bolster, and thus the truck side bearing on that side, to drop with them, thereby removing car support on that side. The center wheels, which are 5 ft. from the end wheels, are on level track. At the instant that the side bearing support of the car is removed and the car starts to roll to that side, the chafing



Side View of the Boyden Truck, Showing the Construction of the Frame and Bolster

plate of the snubbing block comes in contact with the car floor and arrests the movement of the car before it accumulates any appreciable momentum. In a very short increment of time, the leading or trailing wheel is again on level track and the side bearings steady the car as the center wheel in its turn drops into the rail depression. This feature has been found to reduce the car oscillation at critical speeds to a marked degree, and without overloading of the center journals.

The Design May Be Varied to Suit Conditions

The Boyden trucks, from the nature of their construction, can be designed for a maximum wheel base. The demonstration trucks are equipped with wheels having a total wheel base of 10 feet. This produces a satisfactory distribution of the load to the rails, roadbed and structures, which tends to reduce maintenance of way costs.

It can be seen from the side view of the truck that all of the important parts are accessible for inspection. This is an important feature of the truck and can be appreciated by those who have the responsibility of safe operation of cars. The clasp brake rigging is also as easily accessible as the main members of the truck. Shoe replacements can be made without removal of the dependent parts and can be accomplished without unnecessary loss of time.

The four main members of the truck are self-interlocking

and require no bolts, pins or rivets to complete the assembly. Springs located over the journal boxes cushion the rail impacts before these depreciating forces enter the truck structure and thus retard crystallization of its cast steel members.

The following advantages are claimed for this truck:

1—Safe operation under abnormal loading and truck conditions secured by a snubbing of the car oscillation and thereby obtaining better vertical equalization with the attendant elimination of the hazard of lifting wheels.

2—High speeds are made possible for modern freight cars of greater capacity.

3—The curve resistance is reduced to a minimum due to the frame construction which permits all the wheels to adjust themselves to the curve, with a corresponding reduction in drawbar pull and reduced wear on the wheels and rails.

4—Equal flange and tread wear on all six wheels is obtained owing to the radial position assumed by the axles on curves.

5—Better distribution of rail loading is secured by the greater wheel base with an attendant reduction in maintenance cost.

6—The main members of the truck, center frame, two end frames and complete bolster are composed of four self-interlocking parts which require no bolts, rivets, or pins in their assembly.

7—All parts are designed with the view of facilitating inspection in order to reduce the hazard of unseen faults and fractures.

8—The clasp brake rigging is of a simple special design and all parts are visible for proper inspection and maintenance. Replacement of brake shoes can be made without removal of any of the dependent parts.

Shearing Stress in Passenger Car Side Girders

Analysis of Procedure Necessary in Order to Reduce Weight Without Sacrificing Strength

By Wendel J. Meyer

THE new light-weight coaches which recently have been placed in service on several railroads are constructive steps toward reduction of the weight of steam road passenger cars. Although designed for suburban service exclusively, their success, no doubt, will predicate an earnest attempt to reduce the weight of main line equipment. Mooted questions of car design, often have been settled by adding excessive weight in order to err on the side of safety. To reduce weight successfully without sacrificing essential requirements of strength, calls for more careful consideration of the engineering principles involved.

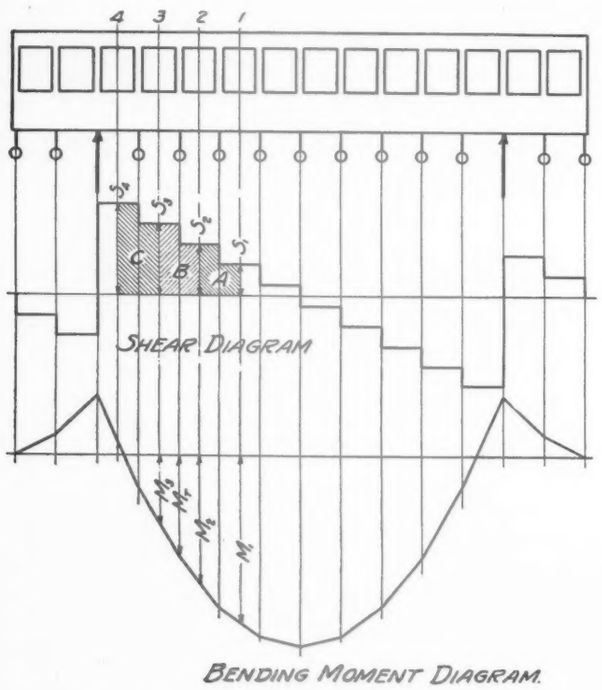


Fig. 1—Shear and Bending Moment Diagrams

The design of the load-carrying side girder presents a number of interesting points. To calculate the bending moment and then divide it by the calculated section modulus of the assumed girder section in order to arrive at prescribed tensile and compressive stresses, does not always assure the ability of the girder to withstand its loads. The investigation is not complete until the shearing stress also has been taken into consideration.

This article is an attempt to explain the action of vertical and horizontal shear; to show the action of the upper and lower chords in resisting vertical shear; to describe the function of the side posts in resisting horizontal shear; to point out the effect on the side girder if the shear is not resisted properly; and to call attention to the action of the center sill in assisting the resistance to shear.

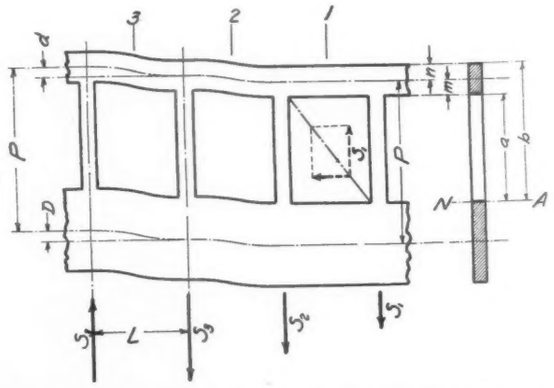


Fig. 2—The Shear in the Chords of a Typical Girder Section

Vertical Shear

Fig. 1 shows the bending moment and shear diagrams of a side girder, which, in order to simplify explanation, is assumed to be loaded by equal weights concentrated at the post centers. The girder section is assumed constant throughout the length of the girder and is represented in Fig. 2; to further facilitate explanation, the neutral axis *NA*, is assumed to coincide with the top of the lower chord.

The shear diagram of Fig. 1 shows the vertical shear at section No. 1 to be S_1. If the upper and lower chords were pin-connected at their ends, a diagonal as shown at window opening No. 1 of Fig. 2, would be necessary and the vertical component of the force in the diagonal would be S_1. It then follows that omission of the diagonal tends to flex the upper and lower chords as shown at panels No. 2 and No. 3 of Fig. 2. The shear, therefore, produces bending stresses in the chords, which must be added algebraically to the stresses due to the moment given by the bending moment diagram.

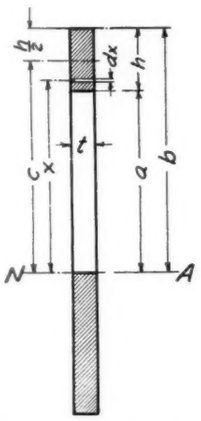


Fig. 3—The Girder Section Analyzed for Chord Stresses

Assuming the posts to be capable of resisting horizontal shear, the vertical shear S_3 will cause a bending moment

$$M_V = \frac{L}{2} S_3$$

which must be resisted by the chords of panel No. 3. The dimension P will not change appreciably because the posts are subjected to low direct stress and so the deflections d and D of Fig. 2, may be assumed to be equal. The upper and lower chords, therefore, are redundant beams of equal deflection and length and so the amount of M_V taken by each will be proportional to the rigidity of each beam which, in turn, is proportional to its moment of inertia.

Let I_U and I_L be the respective moments of inertia of the

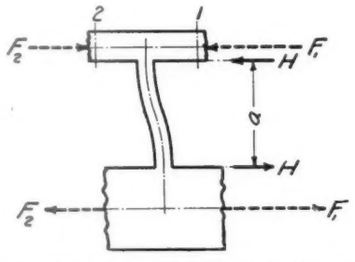


Fig. 4—Horizontal Shearing Effect Caused by the Changing Moments

upper and lower chords, taken about their individual neutral axes. The bending moments due to shear will then be:

$$M_{UV} = M_V \frac{I_U}{I_U + I_L} = \frac{L\ S_3\ I_U}{2(I_U + I_L)} \text{ (on upper chord)}$$

$$M_{LV} = M_V \frac{I_L}{I_U + I_L} = \frac{L\ S_3\ I_L}{2(I_U + I_L)} \text{ (on lower chord)}$$

At the right hand post of panel No. 3, M_V causes compression in the top fibres of the chords and tension in the bottom fibres while at the left hand post the top fibres are in tension and the bottom fibres in compression. It is necessary, therefore, to investigate the sections at both posts but the procedure for the upper chord at the right hand post only, is given here.

Let M_T be the bending moment as taken from the diagram of Fig. 1 and let I be the moment of inertia of the total section, taken about $N\ A$ of Fig. 2; the symbols a, b, m and n are described by Fig. 2. The unit stress on the top fibre of the upper chord is:

$$f_t = -\frac{M_{UV}\ n}{I_U} - \frac{M_T\ b}{I}$$

and the unit stress on the bottom fibre of the upper chord:

$$f_b = +\frac{M_{UV}\ m}{I_U} - \frac{M_T\ a}{I}$$

It is apparent that f_t will be compressive but the sign of f_b will depend upon the numerical values of the component terms. It should be noted that terms containing M_{UV} are numerically maximum for panels near the bolsters and mini-

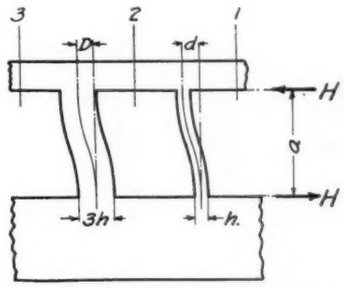


Fig. 5—Typical Section with Wide and Narow Posts

mum at the center of the car, while the terms containing M_T are maximum at the center and minimum near the bolsters.

Force in Chords and Statical Moment of Section

Fig. 3 represents the same girder section as described by Fig. 2. If the section acts as a unit and is subjected to a bending moment M, the unit stress on the fibres distant x from $N\ A$, will be $M \times x \div I$, where I is the moment of inertia of the whole section, taken about $N\ A$. A very small portion distant x from $N\ A$, of width t and depth dx, will

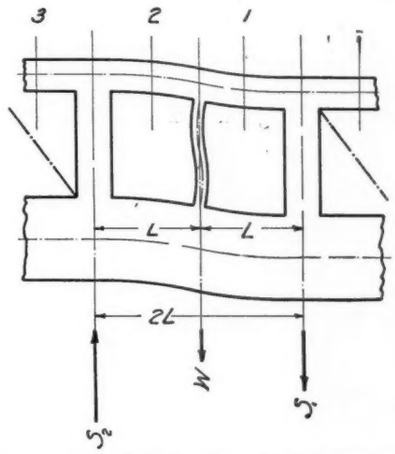


Fig. 6—Effect of Unbalanced Post Sections

have an area of $t \times dx$. The force acting on this area will then be

$$(t\ dx)\left(\frac{M\ x}{I}\right) = \frac{t\ M\ x\ dx}{I}$$

The total force F which acts on the whole section of the upper chord, is obtained by summing up all the small portions of which it is composed or, in other words, by integrating between the limits $x = a$ and $x = b$. This summing up is done by means of calculus and results in

$$F = \frac{t\ M}{2\ I}(b^2 - a^2) = \frac{M}{I}\left(\frac{b+a}{2}\right)(b - a)\ t$$

Reference to Fig. 3 shows that

$$h = b - a \text{ and } b = c + \frac{h}{2} = c + \frac{b-a}{2} \quad \text{or } c = \frac{b+a}{2}$$

Therefore

$$F = \frac{M}{I} c\,(h\,t) = \frac{M}{I} c\,A$$

where A is the area of the upper chord.

The quantity $c\,A$ is known as the statical moment M_s of the section about $N\,A$. It is obtained by multiplying each component area included between the horizontal plane of shear and the extreme fibre, by the distance from the center of gravity of the component area, to the plane under consideration. The statical moment is a maximum for the plane through the neutral axis and so the maximum horizontal shearing stress is at the neutral axis of the section. Substituting $M_s = c\,A$ in the above equation, there results:

$$F = M \frac{Ms}{I}$$

Horizontal Shear and Its Effect on the Posts

Fig. 1 shows the bending moments at sections 1 and 2 to be M_1 and M_2 respectively. Then the compressive forces

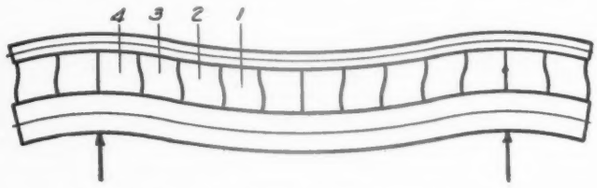


Fig. 7—The Action of Flexible Posts Incapable of Transmitting Horizontal Shear

F_1 and F_2 acting on the upper chord at sections 1 and 2 are

$$F_1 = M_1 \frac{Ms}{I} \quad \text{and} \quad F_2 = M_2 \frac{Ms}{I}$$

The action of F_1 and F_2 is illustrated by Fig. 4 where F_1 is greater than F_2 because M_1 is greater than M_2. The difference between F_1 and F_2 is

$$H = F_1 - F_2 = \frac{M_1\,Ms}{I} - \frac{M_2\,Ms}{I} = \frac{Ms}{I}(M_1 - M_2)$$

Since the bending moment diagram is the integral of the shear diagram it follows that M_1 equals M_2 plus the shaded area A of the shear diagram of Fig. 1. Then

$$M_1 - M_2 = \text{area } A \quad \text{and} \quad H = \frac{Ms}{I}(\text{area A})$$

The force H is the horizontal shear or the tendency of the upper and lower chords to slide past each other, which must

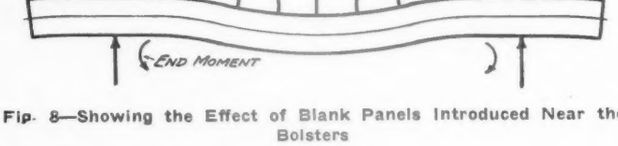


Fig. 8—Showing the Effect of Blank Panels Introduced Near the Bolsters

be resisted safely by the post if the girder is to act as a unit.

If the post is rigidly connected to the upper and lower chords it will bend as shown in Fig. 4 and the bending moment is $H \frac{a}{2}$ but if the connection to the upper chord is not sufficient, the bending moment should be taken as $H\,a$.

Effect on Alternate Wide and Narrow Posts

If the posts are alternately wide and narrow, the typical section will take in two windows as shown in Fig. 5. Then the shear to be resisted by one post of width h and one of width $3h$ will be

$$H = \frac{Ms}{I}(M_1 - M_2) = \frac{Ms}{I}(\text{area A} + \text{area B})$$

The bending moment is $H \frac{a}{2}$ and the amount taken by each post will be proportional to its moment of inertia as explained under "Vertical Shear," because d will not be appreciably different from D.

A system of equal posts can be compared to one of alternate wide and narrow posts by assuming all post sections to

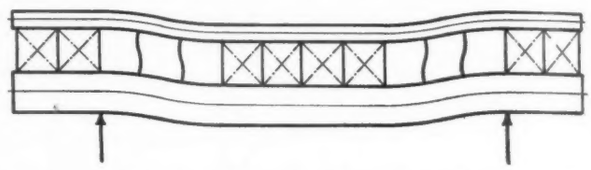


Fig. 9—Illustrating the Action of the Girder Which May Occur Where the Shearing Stresses Near the Center of the Car Are Well Within the Capacity of the Posts to Resist Them

be similar and assigning widths of $2h$, $3\,h$ and h to equal, wide and narrow posts respectively; the window openings of both systems will then be equal. The respective moments of inertia for widths h, $2\,h$ and $3\,h$ are then $K\,h^3$, $8\,K\,h^3$ and $27\,K\,h^3$ and the section modulii: $C\,h^2$, $4\,C\,h^2$ and $9\,C\,h^2$; where C and K are constants of section. The bending moments and stresses will then be as follows:

Width of Post	Bending Moment		Stress	
h	$\left(\frac{H\,a}{2}\right)\left(\frac{K\,h^3}{K\,h^3 + 27\,K\,h^3}\right)$	$= \frac{H\,a}{56}$	$\frac{H\,a}{56\,C\,h^2}$	$= .0178\,K'$
$3\,h$	$\left(\frac{H\,a}{2}\right)\left(\frac{27\,K\,h^3}{K\,h^3 + 27\,K\,h^3}\right)$	$= \frac{27\,H\,a}{56}$	$\frac{27\,H\,a}{56\,(9\,C\,h^2)}$	$= .0535\,K'$
$2\,H$	$\left(\frac{H\,a}{2}\right)\left(\frac{1}{2}\right)$	$= \frac{H\,a}{4}$	$\frac{H\,a}{4\,(4\,C\,h^2)}$	$= .0625\,K'$

K' is a constant involving H, a, C and h^2.

The comparison shows the stress in the wide posts to be about 86 per cent of the stress in equal posts placed at the

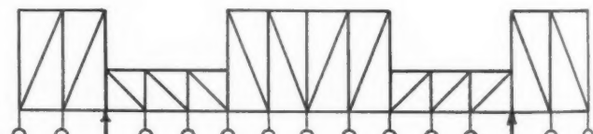


Fig. 10—Truss Diagram Illustrating the Virtual Value of the Girder Shown in Fig. 9

same points. It is questionable whether this reduction warrants the constructional disadvantages encountered in the use of unequal widths of posts. Furthermore, since the narrow post usually will be found incapable of transmitting the shear across its adjacent panels such as $H = \frac{Ms}{I}(\text{area } A)$ to which it is subjected, the upper and lower chords will act as shown in Fig. 6; the bending moments in the chords will be materially increased because the vertical shear here must be transmitted over two panels instead of over one.

Effect of Blank Panels at Bolsters

Fig. 7 represents a girder with flexible posts incapable of transmitting any horizontal shear. Here the upper and lower chords are beams with equal deflections, each bending about its own neutral axis because the girder cannot act as a unit since the horizontal shear is not resisted.

Blank panels at or near the bolsters as illustrated by Fig. 8, have been employed with the idea that this construction will enable the girder to act as a unit. But this arrangement does not relieve the posts from the shear action. In order that the girders may act as units, the posts of Fig. 8 must resist the same shear as the posts of Fig. 7. It should be noted however, that the girder of Fig. 8 is considerably stronger and stiffer than that of Fig. 7 because the blank panels virtually constrain the ends of the upper and lower chords and create end moments as shown; the chords approach the condition of beams rigidly fixed at their ends.

Action of the Usual Side Girder

An analysis of the usual modern coach will show that while the posts near the center of car will safely transmit their

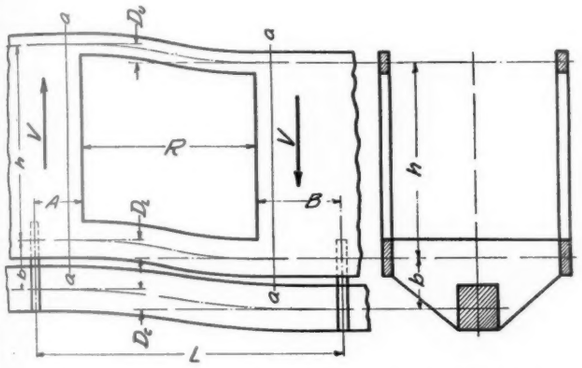


Fig. 11—Frame Members Available to Resist the Vertical Shear at a Door Opening

portion of the shear, the posts near the bolsters are incapable of resisting the shear necessary to produce a unit girder.

Since the bending stresses in the posts are functions of the increment areas of the shear diagram such as area *A*, area *B*, etc., it follows that the post stress depends upon the change of bending moment for adjacent panels of the girder. At the center of the car the change of bending moment is small while near the bolsters, the bending moment changes rapidly. This is shown by the bending moment diagram of Fig. 1; further, reference to the shear diagram shows that the proportion between area *C* and area *B* is greater than that between area *B* and area *A*. Therefore theoretically, beginning at the center of car, the post sections should be increased as the bolsters are approached but, for the sake of appearance, this is hardly desirable, even though it were practicable.

Failure of the posts to transmit the shear adequately, does not mean that the girder will fail under its load because the action illustrated by Fig. 9, may occur. That is, at the center of car the shear is small and the posts are capable of resisting it: thus fully developing the unit girder to resist the maximum bending moment. Near the bolsters, the posts cannot resist the large shear but here the bending moment has decreased to such a value that the entire girder is not needed to resist it; the portion between side sill and belt rail, is capable of resisting the reduced bending moment at this point. Between bolsters and ends, the shear is small and aided by the body corner posts and vestibule end construction, the intermediate posts are capable of resisting it. The virtual effective girder, therefore, is similar to the truss shown in Fig. 10.

This suggests the plausibility of using flexible posts or flexible post connections at those points of the girder where the regular posts are incapable of transmitting the shear safely. Such an arrangement would eliminate possible cracks in the posts at letter board and belt rail. Of course, it would be necessary to determine how far from the center of car the entire girder section is needed to resist the bending moment, to design the necessary rigid posts so that the entire girder section will be assured over this distance and to see that the upper and lower chords acting as redundant beams in way of the flexible posts, are capable of resisting their imposed bending moments.

It should be noted that in the preceding discussion, the action of the center sill in aiding the resistance to the vertical shear, has been neglected. The effectiveness of the center sill will depend upon its rigidity as compared to that of the chords and also upon the location of the crossbearers. The following remarks on the action of the center sill at baggage door openings apply also to its action at window openings.

Vertical Shear at Door Openings

Fig. 11 represents a portion of the side girder at a door opening and shows in section the five longitudinal members—two upper chords, two lower chords and the center sill—which must resist the vertical shear *V*. To simplify the work of calculating, it is necessary to propose the following assumptions, which, while only an approximation of the truth, will not affect practical results appreciably:

First—the cross bearers are assumed to connect, with perfect rigidity, the center sill with the lower chords thus making the dimension *b* of Fig. 11, constant; the usual cross bearer is comparatively short and very rigid.

Second—the ends of the center sill and chords are considered fully restrained; the chords approach this condition closer than does the center sill.

Third—the deflection of the side girder over the lengths *A* and *B* of Fig. 11, is zero; the moment of inertia of section *a* — *a* is very large compared to the individual moments of inertia of each chord and of the center sill.

Fourth—the distance *h* remains constant; the direct stress in the door posts is small and there is no appreciable change in their lengths.

Under these assumptions, all five members must have the same deflection and so the portion of the shear *V* taken by each will be directly proportional to its moment of inertia and inversely proportional to the cube of its length. Let V_U, V_L and V_C be the amount of shear taken by each upper and

	MEMBER	MOM. INER. IN.⁴	SEC. MOD. IN.³	LENGTH INCHES.	VERT. SHEAR. LBS.	BEND'G. MOM. INCH LBS.	UNIT STRESS. LBS./SQ.IN.
CASE I	SIDE PLT. & RE-ENF'M'T.	12	3	72	940	33,840	11280
	" SILL & "	80	16	72	6260	225,360	14080
	CENTER SILL	700	100	154	5600	431,200	4310
CASE II	SIDE PLT. & RE-ENF'M'T.	20	5	72	1280	46,080	9220
	" SILL & "	100	20	72	6420	231,120	11560
	CENTER SILL	700	100	154	4600	354,200	3540
CASE III	SIDE PLT. & RE-ENF'M'T.	12	3	72	890	32,040	10680
	" SILL & "	80	16	72	5920	213,120	13320
	CENTER SILL.	840	120	154	6360	489,720	4080
CASE IV	SIDE PLT. & RE-ENF'M'T.	12	3	72	715	25,740	8580
	" SILL & "	80	16	72	4770	171,720	10730
	CENTER SILL.	700	100	120	9030	541,800	5420

Fig. 12—Table Showing the Effect of Varying the Properties of Chords and Sill

lower chord and the center sill respectively. The deflection of each may then be expressed in terms of its load, length, moment of inertia and a constant *K* denoting the material and the manner in which the load is applied. Using *R* as the length of the chords, *L* the length of the center sill and subscripts of *I* to denote the respective moments of inertia, the expressions for deflection are written and equated as follows:

$$D = D_U = D_L = D_C = K\,V_U \frac{R^3}{I_U} = K\,V_L \frac{R^3}{I_L} = K\,V_C \frac{L^3}{I_C}$$

from which

$$K\,V_U\frac{R^3}{I_U} = K\,V_C\frac{L^3}{I_C} \text{ or } V_U = V_C\frac{L^3 I_U}{R^3 I_C}$$

and

$$K\,V_L\frac{R^3}{I_L} = K\,V_C\frac{L^3}{I_C} \text{ or } V_L = V_C\frac{L^3 I_L}{R^3 I_C}$$

A third equation results from the relation

$$V = 2\,V_U + 2\,V_L + V_C$$

which makes possible the solution for the three unknown quantities, V_U, V_L and V_C as follows:

$$V_U = \frac{V\,L^3\,I_U}{2\,L^3\,(I_U + I_L) + R^3\,I_C}$$

$$V_L = \frac{V\,L^3\,I_L}{2\,L^3\,(I_U + I_L) + R^3\,I_C}$$

$$V_C = \frac{V\,R^3\,I_C}{2\,L^3\,(I_U + I_L) + R^3\,I_C}$$

Fig. 12 is a table in which given properties have been substituted in the above equations using 20,000 lb. as the value of V; the resulting distribution of this shear, the bending moments and the unit stresses are shown. Four cases are given in order to show the effect of varying the properties of the chords and of the sill and changing the spacing of the cross bearers.

Attention is called to the convenient check on the calculated shear distribution from the relation

$$2\,V_U + 2V_L + V_C = V$$

which applied to Case I results in

$$2\,(940) + 2\,(6260) + 5600 = 20{,}000$$

In Case II the resistance of the upper and lower chords has been increased 67 per cent and 25 per cent respectively but the center sill is the same as in Case I. The ratios of moments of inertia and section moduli have been maintained because the depths of the chords are usually limited in practice and increased resistance may be obtained only by the use of considerable additional material. The increased sections have reduced the unit stresses about 18 per cent which is small compared to the material added.

In Case III the chords are the same as in Case I but 20 per cent has been added to the resistance of the center sill resulting in a decrease of five per cent in the unit stresses. It should be noted that since considerable variation of center sill depth is possible, the resistance of the sill can be increased more economically than that of the chords.

The importance of the spacing of the cross bearers is shown by Case IV where the door opening and sections of Case I are used but the distance between cross bearers has been shortened 34 in. Without adding material, the high stresses in the chords have been reduced about 24 per cent while the low stress in the center sill has been increased about 25 per cent.

In the light of this comparison, the advantage of elaborate chord re-enforcement seems doubtful; such re-enforcement certainly is not economical. Moreover, the re-enforcement is only effective when it is carried beyond the door opening far enough to enable its connection to develop its full section. On the other hand, reducing the distance between crossbearers enables the center sill to take a greater share of the vertical shear and, even though the sill be increased to secure additional resistance against the imposed load and the cross bearers be strengthened to transmit the increased center sill reactions, it is obvious that this method is more economical than adding re-enforcement to the chords.

Aishton Addresses Car Inspectors and Foremen

Annual Convention at Chicago Listens to a Large Number of Able Addresses and Papers on Car Subjects

THE twenty-third annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, was held at Chicago, September 23, 24 and 25. Probably at no previous convention of this association was a program presented which contained so many addresses by railroad men acknowledged to be leaders in their respective fields. On the opening day of the convention, R. H. Aishton, president of the American Railway Association, delivered a short address which was an inspiration to the members. F. W. Brazier, assistant to the general superintendent of rolling stock of the New York Central, was also roundly applauded after making a short talk in which he emphasized the absolute necessity of efficiency in the car department if railway operating expenses are to be kept within reasonable bounds. Mr. Brazier said that without the hearty support and co-operation of the car inspectors and car foremen and particularly their efforts to develop competent younger men to fill the ranks, efficient operation of the car department would be impossible.

The subjects of car repairs and lubrication were covered in several individual papers. H. W. Williams, special representative to the general superintendent of motive power of the Chicago, Milwaukee & St. Paul, delivered a paper on "Efficiency in Heavy Car Repair Shop Operation," and J. A. Roberts, chief A. R. A. clerk, Chesapeake & Ohio, discussed the subject, "Steel Car Repairs." The subject of "Freight Claim Prevention" was covered by Joe Marshall, special representative, American Railway Association. P. Alquist, master car builder of the Delaware, Lackawanna & Western, read a paper on "Automobile Loading in Closed and Open Cars."

Much favorable comment was heard on the individual paper on "A. R. A. Billing" by B. F. Jamison, special traveling auditor of the Southern. This paper dealt with a subject, the importance of which is under-estimated in some quarters and which some car foremen apparently think can be safely relegated to the billing clerks. Mr. Jamison pointed out in a forceful manner the possibilities of individual roads saving, and conversely losing, not thousands, but probably millions of dollars depending upon whether or not they handle the A. R. A. billing in a systematic manner in accordance with the rules, employing constant checks of all kinds to maintain the accuracy of the work. Abstracts of the papers mentioned, together with the discussion of A. R. A. billing rules and rules of interchange, will be published in this and subsequent issues of the *Railway Mechanical Engineer*.

New Officers

At the suggestion of President Westall, an additional vice-president's office was created, in order that the various incumbents will have a better knowledge of their duties when advanced to the position of president. The new officers of the Chief Interchange Car Inspectors' and Car Foremen's Association are as follows: President, C. M. Hitch, district master car builder, Baltimore & Ohio, Cincinnati, Ohio, first vice-president, W. P. Elliott, general foreman, Terminal Railroad Association, East St. Louis, Ill.;

second vice-president, B. F. Jamison, special traveling auditor, Southern, Meridian, Miss.; third vice-president, E. R. Campbell, general car foreman, Minneapolis Transfer Railroad, Minneapolis, Minn. M. S. Sternberg, master car builder, Belt Railway of Chicago, was re-elected secretary-treasurer, C. J. Hayes, traveling A. R. A. supervisor, New York Central, Yonkers, New York; W. M. Pyle, accountant, Southern Pacific, Tucson, Ariz.; L. Martin, chief car repairer, Baltimore & Ohio, Baltimore, Md., and T. S. Cheadle, chief car inspector, Richmond, Fredericksburg & Potomac, Richmond, Va., are the newly elected members of the Executive Committee.

Address by R. H. Aishton

In his address R. H. Aishton, president of the American Railway Association, spoke in part as follows:

The average layman's or shipper's knowledge of transportation is largely confined to the fact that he may at will be transported from place to place with safety, or that he can consign his goods to advantageous markets with no more personal effort than he might use, in anger, to consign other objects to farther destination. To him transportation is abstract; he has no thought of the detailed work and study that is devoted to perfecting the facility he is using. I venture to say that not one in one thousand shippers knows of the work of the chief interchange car inspector or of the car foreman. Yet what detail of transportation is more essential than that the equipment carrying the commerce of the country be in physical condition to perform the service in which it is engaged?

The position you hold is important or it wouldn't exist. It may not hold a romantic place in the public eye, yet it is essential and upon your work as much as upon any of the other ramified details of the railroad plant rests the responsibility for a smooth working transportation machine which the shipping public has accustomed itself to expect. This is in itself a reward.

The public is chiefly concerned with service and secondarily with the economy and efficiency with which this service is manufactured. One of the things that produced success last year, and is bringing it now, is the movement per car per day. One mile per car per day means automatically adding 100,000 cars to the equipment of the country. You gentlemen can have a large and important part in bringing about that result. Cars in bad order in moving trains cost money in switching out, and entail delay to equipment and freight being carried, on top of the cost of making repairs. This can be reduced to a minimum only by complete knowledge and an intelligent inspection by the inspectors and car foremen.

Expedition in movement of freight depends in a large measure on the care and inspection of cars before loading. Carelessly inspected and prepared cars make it almost an assured fact that the freight will be delayed in transit and possibly require the transfer of the load to a suitable car at the first interchange point; all of which goes to keep down the mileage made by cars and increases the cost, to say nothing of damage to the contents in transfer and general dissatisfaction resulting therefrom.

I note you have a paper on general lubrication. Neglect of proper lubrication and intelligent inspection brings about a tremendous delay to freight and cars, causing dissatisfaction on the part of shippers, addition to the switching expense and brings about a condition where extensive repairs have to be made. You gentlemen have a large part in controlling this avenue of expense.

Good judgment and conscientious regard for duty on the part of the car foremen and car inspectors is of the utmost importance in enabling the railroads to provide satisfactory service to the public, to obtain the maximum use of freight cars and to reduce the operating costs.

A thoroughly practical and smooth working machine is not only expected, it is demanded. Transportation shortage has not been heard of since 1922. This has been possible only by having the whole-hearted support of every individual whose work contributes to the furthering of transportation. The railroads are now in the height of the period of heavy traffic for the current year. That they will handle this peak without attendant shortage of transportation I feel sure, with the same individual effort as we have had from each of you in the past and with your co-operation.

W. T. Westall (N. Y. C.)
President

C. M. Hitch (B. & O.)
First Vice-President

W. P. Elliott (Terminal R. R. Assn.)
Second Vice-President

A. S. Sternberg (Belt Railway Chicago), Secretary

Address by President Westall

The following is an abstract of Mr. Westall's presidential address:

At our annual meeting last October we had a total membership of 246 active members, today we have a total of 564 active members or an increase of 318 over a year ago. Your president does not accept the honor or credit for increasing the membership to this number, but does have the pleasure of congratulating, first, our worthy secretary, Mr. Sternberg, for the hard and untiring work that he has done to bring this about; second, to the chairman of the membership committee, Mr. Elliott, your second vice-president, whom I desire to sincerely thank for the good work he has done in the campaign to secure new members. On Mr. Elliott's

committee there are many whom I desire to thank for the interest they have taken in securing new members, but here I feel it my duty to make special mention of a few, the first is E. R. Campbell, general car foreman, Minneapolis Transfer Railroad, Minneapolis, Minn., who ran way ahead of his ticket and secured 80 new members; W. R. Rogers, chief interchange inspector, Youngstown, Ohio, a close second with 50 members; B. F. Jamison, special traveling auditor, Southern, Meridian, Miss., 32 members; J. A. Roberts, chief A. R. A. clerk, Chesapeake & Ohio, Richmond, Va., 20 members; Mr. Sternberg, with all of his other duties found time to bring in 30 new members.

Your association today stands on solid ground and is recognized by almost all of our high officers together with the American Railway Association. At each convention it brings in new members and associates, as when anyone first attends they are usually anxious to come back each year, and there is no reason now why this should not be one of the largest associations in America. This can be brought about by each member taking an interest in it and bring in at least one new member on or before our 1925 convention.

I hope the young men here will take the opportunity of entering into the discussions of the several papers which will be presented. All of them are very interesting and instructive. Do not be timid in getting up and expressing your views.

Here, I would like to call your attention to Article 6 of our Constitution and By-laws which reads, "No member shall speak more than twice on the discussion of any question until all members have had an opportunity to speak." I feel that in fairness to the younger members, we should give them an opportunity to express their views, but I hope you will all feel free to enter into discussion without being called upon by the chair.

Your president believes the time is now here when a change in our present By-laws should be made by providing a third vice-president, in order that that officer may advance to the office of second vice-president and then to president so that he will become more familiar with the duties of the president when elected to that office. Second: That due consideration be given to an increase in the salary of the secretary and treasurer in order that it be made more attractive and recompense that officer more in line with the attendant work. As I have been in touch with Secretary Sternberg much in the last year, I know that the volume of work that he has handled is not appreciated by many of us. I feel that the association now can well afford to double the salary and I hope you will give this matter due consideration before the convention adjourns.

Work That Can Be Done

Much can be done by all of us after attending these annual meetings by returning home and correcting or putting into effect the conclusions reached. I would here like to call your attention to a recent decision rendered by the United States Supreme Court in which action was brought against one of our large trunk lines for hauling "Cars with Defective Power Brakes after Passing a Repair Station." A synopsis of this case was as follows:

In an action by the government against the railroad company for penalties under the federal Safety Appliance Act, the Circuit Court of Appeals, Third Circuit, certified to the Supreme Court of the United States the following question of law: "May an interstate carrier lawfully operate a car equipped with power brakes past an available repair station to destination when its power brakes, becoming out of order in transit, have been cut out of the power brake system of the train and when more than 85 per cent of the cars of the train are equipped with power brakes controlled by the engineer of the locomotive?"

The Supreme Court answered: "No, unless placed in the train in the rear of all cars having their brakes operated by the engineer."

This decision means nothing else than that all trains passing an inspection or repair point must have their brakes cut in and operating, although the point in question at which the decision was made, was not even considered an inspection point. No regular force of inspectors was employed, although a repair shop was located adjacent or near the train yard. It was considered simply a terminal point for change of engine and train crews, the same engines departing with the trains which hauled them in.

I am simply mentioning this case to point out the need of closer attention to our air brake equipment in order that further action will not be brought against the American railroads. You are the men behind the gun and you can do considerable to bring about an improvement in the maintenance of our air brake equipment.

On this same question I desire to direct your attention to the recent air brake investigation made by the Interstate Commerce Commission which is reported in the *Railway Mechanical Engineer*, September, 1924, in which Commissioner McManamy brings out evidence showing the need for better maintenance of power brake systems. Improved performance will result therefrom, it being the consensus of opinion of the witnesses who testified at these hearings that the present freight brake equipment with "K" type triple is adequate if properly maintained. So you appreciate members that this question now is a very important one and it is our duty to bring about a better maintenance of our air brake systems or have legislation brought about compelling radical changes in our present systems.

A. R. A. Car Repair Billing

By B. F. Jamison

Special Traveling Auditor, Southern, Meriden, Miss.

Never before in the history of the operation of railroads was there the evidence of interest in A. R. A. car repair billing as now. In fact, until a few years ago, little attention was paid to the subject by any others than those directly handling it, who in many cases had little opportunity to study the business. As a result few persons realized the importance of the work which was performed with little regard to accurate accounting.

Of late years, owing to the interest being taken by higher officials of the different railroads, the rules have been extended and enlarged to cover more perfectly car repairs and the accounting therefor. Today we find that car repair billing has become a system of records and accounting, the equal of that employed in any other of the various departments of railroad work and operation.

We have just said that car repair billing has become a system, and this is true. I would like to impress upon you just here that system must be employed in this work, and unless you do have system, you can never expect to have anything like accuracy or to comply with the A. R. A. rules of the present day.

Present Rules Highly Effective

After 27 years of study of the A. R. A. rules and the daily application of them I am glad to say that I am better pleased with our present rules, than ever before, as they more perfectly and justly cover all conditions and situations than in the past.

Recognizing the need of greater care and the adoption of system in the work of car inspection, repairs and billing therefor, the American Railway Association adopted the present Rule 6 of the 1923 Code which refers to "Regulations Governing Inspection and Repairs of Foreign Cars and Billing therefor under the A. R. A. Rules of Inter-

change." This specifies the methods of recording, inspection and repairs of cars and billing therefor, as well as the filing of such records, and, further, that this work shall be in accordance with these regulations.

The adoption of these regulations is the most forward step of the A. R. A. in many years towards bringing about a system of just, honest and accurate car repair billing, on and between the various railroads, members of the association. There is need of careful study of these regulations, testing out your own system, to see if your railroad is complying therewith. If you are not doing so, then you are not keeping up with the progress being made by other roads in the subject of this paper.

If you have not already put system into your car repair billing, then you should do so at once, and, having adopted a system, see that it is carried out in all its details. This and this only will insure your getting results in the work.

Car Foremen Vitally Interested

There has been a practice on the part of many car foremen to leave all matters concerning car repair billing to the A. R. A. clerks, allowing other matters to occupy their full attention and in many cases interest as well. Just a short time ago, I was speaking before a body of men by invitation, and previous to the meeting was introduced to a car foreman with the statement that I was to speak to them on "A. R. A. Car Repair Billing." This car foreman greeted me with the statement—"Well, I think there will be a number of A. R. A. clerks present tonight, and I am sure your talk will be very interesting to them." Now gentlemen, I want to ask you—Why more interesting to them than to him? I am just wondering who here today are most interested in my paper, the A. R. A. clerks or the car foremen?

I submit to you, the statement that there is no knowledge more necessary to the successful car foreman than that of the rules governing billing for the repairs to foreign cars, carding for improper repairs, correcting improper repairs on both foreign and home cars and repairs made on authority of defect card, for without this he cannot properly plan or supervise the work of car repairs.

Often the question has been asked, to name the rules governing car repair billing. All of the rules to a greater or less extent in some manner effect the handling of car repair billing, therefore, it is necessary for a person handling this work to have a knowledge of all the rules.

The Personnel of the System

We will now consider the requirements of the various persons, who have in their order, the responsibility of executing the system of car repair billing.

The Car Inspector—Whether on interchange, train yards or at freight houses and loading stations, it becomes necessary that he shall make minor repairs to cars, and it is his duty to make correctly an original record of these repairs, according to the rules, in order that where a bill is in order, it can be prepared, or where no bill is in order, that the records will clearly indicate the fact.

All material used by him must be properly described according to the descriptions in Rule 101, with such additional information as affect the charges. For example, if an angle cock is applied, it must be shown if the "self-locking handle type" was applied, and if the same type or plain handle was removed, in order to arrive at the correct charge. The reason for repairs must be shown, to determine if any charge is due against the car owner, or if it is a handling line responsibility. In the case of repairs made necessary on account of damage caused by Rule 32 conditions, the fact must be clearly shown on the original record. The location of repairs must also be shown, according to Rule 14.

It is necessary in many cases that information, shall be shown as to the manner of the application of material, such as the number of bolts, nuts, lag screws or pins and cotters removed and replaced in order to enable the person preparing the billing repair card to apply the correct labor charges.

Where the rules provide for a different charge for new or second-hand material or no charge, unless new material is used, it is also necessary that material shall be shown as new or second-hand.

It must now be clear that the car inspector in order to perform this part of his work, must not only be familiar with the parts of cars, but also with the descriptions of material as used in the rules as well. He must be acquainted with the labor allowances for the various operations usually performed by him, as given in Rules 107 and 111.

Nicknames no matter how common should not be used in making original records; for example, "staybolt nut" for column bolt nut, "lock pin" for knuckle lock, "brake idler" for brake lever guide, "hog rod" for body truss rod, etc.

When the car inspector finds repairs necessary, which require that a car be sent to the shop or repair tracks, it then becomes his duty to make careful inspection of the car and apply a "Bad order card" which should show the following information: Date and hour shopped, with inspector's signature or initial; train number in which received, place or location found; principal defects for which shopped, with location according to Rule 14.

Where damage was caused by any of the conditions set forth in Rule 32, this information must be shown. The bad order card should then be securely attached to the car in order that it will remain there until such time as removed by an authorized person. Where various tracks are provided for different classes of repairs, the bad order card should in some manner indicate the track to which it should be switched.

When cars are received in trains with missing material, such as draft gear or side doors, the car inspector should endeavor to obtain from the train crew where this material was left, or the car picked up, and show this information on his original record of the shopping of the car, for the information of the car foreman.

When cars are received in trains showing damage to have been caused by unfair usage the car inspector should obtain information from train crew and show it on the original record of shopping of the car, for the information of the car foreman and work inspector.

The car inspector should then make his original record (preferably on a loose leaf form) of the shopping of the car, which form should show all the information required on the bad order card with the additional information as to the shop, track, or point to which it is ordered for repairs.

Should derailment or any other accident occur while he is on duty, the car inspector should make a full and complete report on a form provided.

The original records of all repairs made by him, with the original record of all cars shopped, and reports of any yard accidents occuring, should be sent to the car foreman's office before the car inspector goes off duty.

The Car Foreman—On the arrival of shopped cars at repair tracks or shops they should be carefully inspected by the car foreman, preferably with the assistance of the work inspector, or person whose duty is to make the original record of repairs made, often called the "Write up man." When it is decided what repairs are to be made, they are recorded by the car foreman or work inspector on the original record of repairs form, loose leaf form preferred.

In authorizing repairs to be made, the car foreman should see that only proper repairs are made. In order to do this he must be familiar with the latest A. R. A. standards and recommended practice and understand the requirements of the rules, especially Rules 17, 87 and 88. He should know what material he has in stock, and in case he has not

the proper material to make repairs, he should take immediate steps to obtain it and if necessary order it from the car owner, doing so in accordance with Rule 122 immediately, in order that there be no unnecessary expense of per diem. Many car foremen hesitate to incur the expense of a few days per diem, while not hesitating to incur a much greater expense in assuming the liability for making improper repairs.

The file of accident reports, should at all times be accessible to the car foreman and work inspector, and whenever the appearance of damage indicates a possible accident, should be referred to in order that the proper action may be taken as to handling the repairs and making the original record of same. All original records should be preceded by the words "Bill owner" or "No bill."

The car foreman should, when it is necessary to make improper repairs, check them carefully and issue his company an A. R. A. defect card, attaching it securely to the car before the car is marked O. K. to pull. A knowledge of the provisions of Rules 17, 87 and 88 are particularly necessary to do this correctly.

Temporary repairs should only be made as a last resort. It has been my experience that often, as much material and labor has been consumed in making temporary repairs as would have been required to make proper repairs, the result of which was a direct loss, as no bill can be rendered.

As the car foreman's signature is required to the original record of repairs, it will be plain that he must at all times be familiar with this part of the working of the system.

The Work Inspector—The preparation of the original record of repairs made by small repair forces is usually done by the car foreman in charge, while in larger places a regular man is assigned to this work whom I call the "work inspector." In order that your original records shall be correct in all the details necessary to render your bills perfectly, it is necessary that the person intrusted with this work shall be familiar with the A. R. A. rules of interchange and regulations referred to in Rule 6.

By all means, he should write a plain hand, easily and quickly read and not mistaken. In order that he will give the proper description of material used, he must be well acquainted with the construction of cars, keep posted as to the ever-increasing improvements adopted and in use on foreign cars, use terms and descriptions as shown in the rules in applying material listed therein.

The making of the original record of repairs is perhaps the most important of all the parts of the system of car repair billing. Therefore it follows that the person intrusted with this work must be an experienced man, must make the original record directly at the car, and not from memorandum taken down by some one else or himself in a book or otherwise. The loose leaf form is much the best for the original record. All information required for the preparation of the billing repair card must be shown. The weights of such items as can be calculated from the A. R. A. scale of weights, issued Feb. 20, 1922, Circular DV-226 need not be shown, the weight of all other items charged by weight should be actual scale weight and not estimated. Board feet of lumber need not be shown, but correct dimensions must be given, using the finished size for all dressed or matched stock, and, where the lumber used is rough, the original record must show "rough" following the dimensions.

In the description of material used, great care must be taken to give the correct information. In Rule 101 the various prices shown for the different materials and articles vary as to the type, size or composition of the material or articles. Common errors occur in the description of triple valves, pressure retaining valves, angle cocks, couplers, and brake beams, it being necessary to show in all these cases not only the kind applied, but that removed also, in order that the correct charge may be made by the A. R. A. clerk on the billing repair card. To describe material simply as "steel" is not sufficient, for a different price is given for cast steel, plate (or sheet) steel, pressed and flanged steel which is plate steel formed into certain shapes required, fabricated pressed and flanged steel which is two or more pieces of this material riveted together to form a certain part or article, and then composite fabricated which is pressed and flanged steel to which or with which other metals are combined with rivets. The word "fabrication" does not apply to the rivets used in applying parts to cars, but to the shop construction of parts. When A. R. A. standard material is substituted for non-standard material, both articles must be clearly described. Where material has been received on requisition from car owners, this information must also be shown on original records in order that the invoice price and freight charges may be obtained, for the billing repair card. Great care must be used in the description of manufactured articles covered by Rule 105. The name of the article used by the manufacturer should be used in order that the correct store room or factory cost may be obtained. Considerable difficulty has been experienced in this line. Personally I learned much by a study of the various advertisements of the numerous railway appliance companies in the current publications such as the *Railway Mechanical Engineer*. I would like to see more illustrations of these patented devices in the advertisements, contained in our annual proceedings. It would be of a wonderful benefit to those who must know the proper names.

It is necessary that the work inspector shall study and memorize the various operations shown in Rules 107 and 111 in order that he can make his records in the proper order with relationship of one item to another.

Showing the major repairs for which a specified labor allowance is given in the rules, with the associated items following, will prevent many of the errors in labor charges on billing repair cards. The increasing number of operations which are on the bolt, nut, lag or rivets basis make it necessary that this class of material follow the parts used in connection, in order that labor charges may be made correctly. The purpose for which bolts, nuts, lags or rivets are used should be shown by giving them the name of the part, column bolt, carrier iron nut, pipe hanger lag, sill step rivet, etc.

In many cases the labor for certain items of repairs are included in the charge allowed for other repairs, making it necessary that these associated items be recorded in groups. It therefore becomes highly necessary that the work inspector be familiar with these combinations as shown in Rule 107, many of which require close study.

Where cars repaired have been damaged in accident, reference to the accident report should be made on the original record of repairs, showing the date or number.

Where repairs have been made on the authority of a defect card, the original record should clearly show this, with the railroad, date and number of defect card, place and inspector shown, followed by the repairs made. Partial repairs should be handled according to Rule 5.

The correction of improper repairs on home cars, covered by report of improper repairs should show in the same manner.

The correction of improper repairs on foreign cars, should be made with great care, and records must clearly show not only how repairs were made but the reason for them, with a description of the improper parts, in order that when the car owner receives the repair card there will be no difficulty in handling according to Rule 90.

Where improper repairs are made, the original record must show the number and date of the defect card attached to car to cover same.

The work inspector must be a capable man. I submit to

you that he must be a studious man, one who carries his rule book with him, and one who sees each day's setting sun bring him one more fact or truth in regard to his important work.

Weigh masters' certificates of light weighing of cars, when checked by the painter and signed by him indicating that he has re-stencilled them, become original records for the preparation of billing repair cards.

Repairs made by train crews are to be reported on a form provided for the purpose, and such forms become the original record for the preparation of billing repair cards. Care should be taken to educate train crews to provide correct information as to material and repairs made by them.

Derrick Foreman—The majority of accident reports are prepared usually by the derrick foreman (although many are prepared by car inspectors, freight train conductors and engineers).

It is necessary for the derrick foreman to understand the A. R. A. rules, in order to make his reports of damage to cars properly. Care should be taken to show the real cause of accident, using as far as possible the terms shown in Rule 32. It is also necessary that the derrick foreman understand the application of Rule 112.

Derrick foremen can be of great assistance to car foremen in the handling of material belonging to cars which will be brought to shops. Many times certain cars are destroyed while others with missing draft gear and other parts are loaded and brought to shops and repaired. All such parts should also be loaded and tagged and shipped to the shop with the car. This may require a little valuable time, but it will more than save the expense in the saving of material and delay in repairs.

Each car sent to the shops should bear a bad order card giving information concerning the accident, where, and when damaged, and signed by the derrick foreman.

All accident reports, when received at the car foreman's office should be filed as nearly as possible in date order and numbered consecutively. Where billing repair cards are prepared in other than the car foreman's office, a copy of all accident reports should be furnished the A. R. A. clerk's desk for use in checking responsibility for repairs.

The A. R. A. Clerk—It is the custom on most roads to designate the person intrusted with the preparation of billing repair cards as the A. R. A. clerk. Much that has been said already in regard to the duties and requirements of the work inspector is also true of this person. In fact, it may be truthfully said that the weaker either of these two are, the relatively stronger the other must be. To express it in other words, if your work inspector has not all the knowledge or experience necessary then it is just to that extent more necessary that your A. R. A. clerk shall have.

It is necessary that the A. R. A. clerk be familiar with the rules governing handling, delivering line responsibility, and owners' defects in order that he shall be able to check up with those who have handled the records thus far, to know that they have made no errors, and that bills may be rendered only for those items of repair for which the owner is responsible. No charge should be made where there is none due. Likewise his company must be protected, where protection is due. Defect cards must be handled correctly and according to the rules.

Billing repair cards should be complete in all details as to net prices, labor allowances, weights and classification of materials, scrap credits, and board feet of lumber, before being forwarded to the general office for billing.

It has been the practice on some lines to leave the work of the extension of these items to the general office, but this is not a good practice, for the reason that there are many conditions, combinations and descriptions of materials and repairs, the need of which will not become apparent to the individual writing billing repair cards, until he attempts to make these extensions.

Billing repair cards should be numbered consecutively in order that none may be lost or misplaced, and should by all means be checked against the original record after it has been issued and before being forwarded to the general office. Where two or more A. R. A. clerks are employed in the same office, it is well that one check the other's work; also any car foreman can easily add much to his fund of knowledge by the practice of checking the work of his A. R. A. clerks.

No information can be assumed by an A. R. A. clerk; no net price, labor allowance or other information should be shown on billing repair card which is not supported by the facts shown on the original records. No additional information should be written on the original record by the A. R. A. clerk, or correction made. When such is necessary he must bring the same to the attention of the work inspector or foreman authorizing the repairs, who will add to or correct records as the case may be.

It will naturally be seen that if these things are expected of the A. R. A. clerk, he must be an experienced man, acquainted with the construction of cars and understanding what materials usually are used for the different parts. If this experience has not been acquired by practice then it must be by close observation and teaching.

He should write a good hand, do his work neatly and keep it up to date at all times, he must be familiar with the net prices, scrap credits, labor allowances and various charges allowed, under the various conditions.

As the A. R. A. clerk's work is the last of the system done in the local or district office, it is plain that much responsibility rests on this man. He should carefully study the exceptions taken to his bills and work by the car owner and correct his weakness and errors in future repair cards, in order to eliminate exceptions.

Handling of Accident Reports Important

All copies of accident reports furnished this desk should be kept in a suspense file for ready reference and as fast as bills are prepared for cars shown thereon, the date of repairs are entered and the reports placed in a permanent file for future reference and checking. If this plan is followed out, it will be readily seen that there need be no mistake made as to the responsibility of repairs. As soon as copy of an accident report is received at the A. R. A. clerk's desk, he should ascertain from the daily car record book if the car has been repaired, if so checking his record repair cards to see how the bill was rendered. If an error is found he must take immediate steps to correct it. Otherwise, he will place it in the suspense file until a bill is prepared and then file it in date or numerical order.

All accident reports should be entered in the daily car record book in red ink or red pencil, in order that ready reference may be made at all times to the accident file. This is a small item of work, but will be found of great benefit at all times in handling correspondence as well as billing repair cards.

The system of billing for car repairs would not be complete if there were not periodical checks made by inspectors or auditors. These persons should check the repairs actually made on the cars with the original records during their visit to shops and check various periods of repair cards against the original records on file. Make a report to the proper officials after the exceptions taken have been explained to these concerned and leave a copy at the point checked.

In conclusion I wish to say, that the adoption and execution of a system or plan as outlined cannot be accomplished in a day. It must be the result of an earnest continued effort on the part of all concerned and be adopted by all divisions until the entire road is following the practice.

Recent Decisions of the Arbitration Committee

(The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Car Damaged by a Sudden Train Stop

The American Refrigerator Transit Company's car No. 9466 was damaged while being handled in a train on the lines of the Denver & Rio Grande Western at Echo, Col., August 22, 1921. Both end sills, the two intermediate sills, the two side sills and a portion of the siding and flooring were broken. At the time of the accident the car was empty and was reported to be the sixty-seventh car from the head end of a train of 73 cars. This train was being handled by two engines, one ahead and one on the rear end. As it was being pulled out of a passing track, the brakeman's key caught in the switch lock, and the delay in throwing the switch caused the engineman to make a sudden stop which resulted in the damage to the car. As the result of an inspection made by the car foreman of the Denver & Rio Grande Western, it was decided that the damage was due to weak construction and the handling line submitted an inspection certificate to the American Refrigerator Transit Company in accordance with Rules 43 and 120. The owners claimed, however, that this was a case of damage caused by a misplaced switch which is chargeable to the handling line according to Rule 32, and requested that the handling line either repair the car, or make settlement according to the rules. The handling line, however, contended that the strain to which this car had been subjected, was no more severe on this occasion than it would have been had an emergency stop been made or an air hose burst.

The following decision was rendered by the Arbitration Committee: "There are no conditions which bring this car within the provisions of Rule 32. As the car had not passed over the misplaced switch, this precludes the question of a misplaced switch from consideration. Therefore, the car owner is responsible."—*Case No.* 1303, *Denver & Rio Grande Western vs. American Refrigerator Transit Company.*

Damaged Car Is Received in Interchange

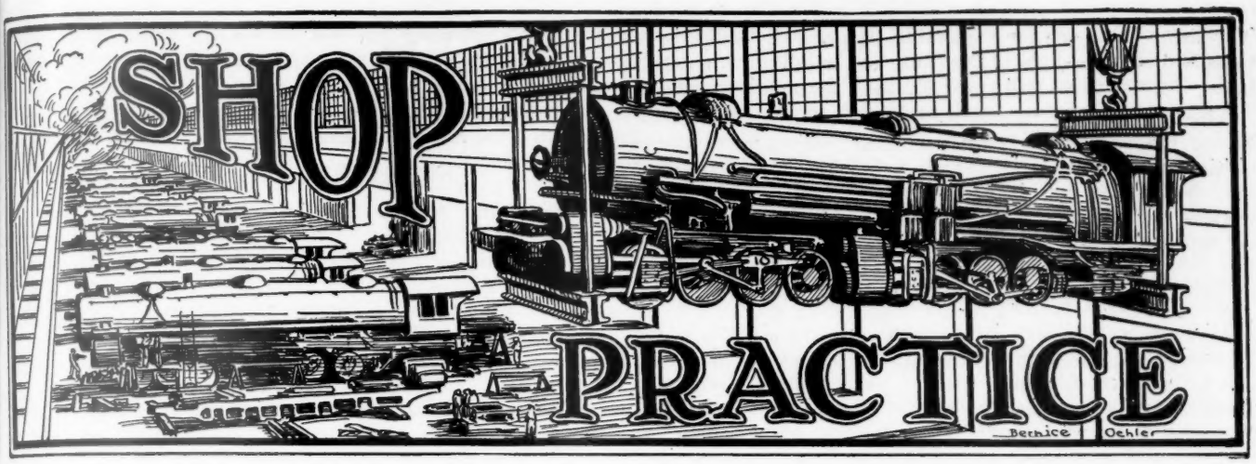
On August 26, 1922, the Indiana Harbor Belt delivered Louisville & Nashville car No. 3131 to the Chicago & North Western at Proviso, Ill., with six longitudinal sills broken near the body bolster. The car was loaded with automobile lamps and the receiving line was compelled to move it to its transfer track where the contents were transferred to another car. While attempting to return the damaged car to the Indiana Harbor Belt, the sills failed entirely and the car collapsed. The Chicago & North Western advised the Indiana Harbor Belt the condition of the car and requested it to handle the case direct with the car owner on account of it being complicated with Rule 43. The Indiana Harbor Belt refused to accept the car, stating that it understood according to Rule 43, that the responsibility rested with the company on whose line the car had failed entirely. The Chicago & North Western submitted evidence which showed that the damage exceeded the limits specified in the note under Rule 43 when the car was delivered by the Indiana Harbor Belt. It contended that it should have been advised as to the exact circumstances under which the car was damaged while in the possession of the delivering line and in case of inability to ascertain these facts the delivering line should assume the responsibility for the damage and handle the case direct with the car owner according to Rule 112. The Chicago & North Western contended further that as the Indiana Harbor Belt did not desire to handle the case direct with the car owner, it should have authorized the Chicago & North Western to do so, as well as to counter-bill against the Indiana Harbor Belt for the depreciated value of the car, which developed to be less than it would have cost to make repairs. The Indiana Harbor Belt refused to do this and rather than penalize the car owner, the Chicago & North Western, not being able to obtain the information required under Rule 43, reported the car under Rule 112 and authorized a bill amounting to $421.88, the depreciated value of the car.

The Arbitration Committee decided that the six sills were broken at the time of delivery of the car from the Indiana Harbor Belt to the Chicago & North Western, and that the Indiana Harbor Belt, failing to furnish a statement showing the circumstances as to whether the damage had occurred in fair usage, according to the foot note to Rule 43, should, therefore, assume the responsibility.—*Case No.* 1305, *Chicago & North Western vs. Indiana Harbor Belt.*

Car Damaged in Hump Switching

Louisville & Nashville box car No. 91415, with a stenciled capacity of 65,000 lb. and of all wood construction, built June, 1905, was damaged in hump switching service, November 13, 1922, on the New York Central. A disposition was requested under Rule 120 for labor costs of $365 and material costs of $350. The circumstances under which the car was damaged are as follows: The brakeman handled a cut of three cars over a hump. He set the brake of the first car and proceeded to the second car to set the brake but found that the brake chain was too long and then proceeded to set the brake on the third car. The cut of cars struck the Louisville & Nashville car which stood first on the track to which the cut was switched and the impact caused the damage. None of the cars involved were derailed, cornered or sideswiped. The car owner contended that the rider lost control of the movement of the cars and requested settlement under Rule 112 while the New York Central contended that the car was not damaged under any of the provisions of Rule 32 and that the damage was, therefore, owner's responsibility. The New York Central in defending its position, stated that Section (c), Rule 120, provides that the owner shall authorize repairs or destruction of the car within 30 days from the date of notification. As no advice had been received from the owner within 30 days, and as the car occupied much needed track room, the handling line issued instructions to dismantle the car. The Louisville & Nashville stated that after reviewing the joint inspection certificate as well as the explanation of how the damage occurred, it was of the opinion that it was a clear case of unfair usage under Rule 32, Paragraph D, Section 3, and requested the handling line on December 11, 1922, to assume responsibility and settle for the car in accordance with Rule 112. The owner had intended to send a representative to inspect the car in the event that the New York Central refused to accept responsibility, but held this in abeyance awaiting reply to its letter of December 11, 1922, which it did not receive until March 27, 1923, after a delay of nearly four months. The New York Central then definitely declined to accept responsibility. The owner then communicated its desire to inspect the car but was immediately advised that the car had already been dismantled. Upon receipt of this information the owner requested that the car be settled for under Rule 112.

The Arbitration Committee decided that the car was not damaged within provisions of Rule 32 and disposition should be furnished under Rule 120.—*Case No.* 1307, *New York Central vs. Louisville & Nashville.*



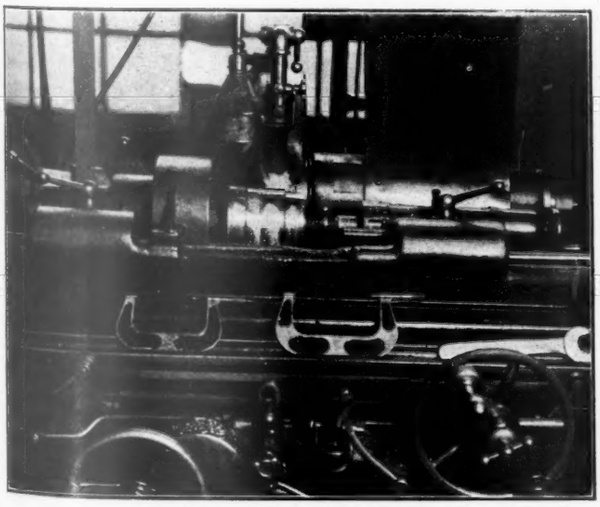
Application of Micrometers in Railway Shops*

Interchangeability of Pins and Bushings for Valve Motion Is Made Possible by the Use of Micrometers

Part III

By M. H. Williams

WHEN repairing locomotives it is important that the distance from the centers of driver axles and also the distance from the center of side rod brasses be correct. Measuring these tram distances or setting adjustable tram points with or from a rule, scale or tape line is entirely possible and often done with complete success. There



Outside Micrometers Are Used When Grinding Knuckle Pins to Fit the Rods

is, however, the possibility of errors owing to the lack of proper knowledge of the correct center measurements, defective rules, etc. There is a further chance for error when one part of the work is done in one department and the remainder in another, such as the erecting shop and rod shop. This is mainly due to the lack of a uniform standard, and, in the event of errors, it is difficult to tell who is at fault. With proper measuring appliances such as the tram bar a convenient and accurate master standard is available, making it entirely practical to lay off the driver box shoes and wedges independent of the rod work with the assurance that each department will use identical measurements.

Tram Bar

A tram bar used for setting the adjustable points for laying off rod centers, laying off shoes and wedges, setting and proving distances between axle centers, etc., is shown in Fig.

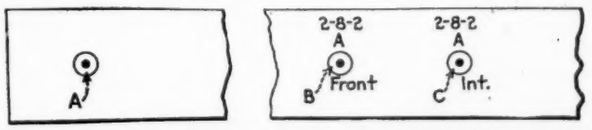


Fig. 1—Tram Bar for Setting the Adjustable Points for Laying Off Rod Centers

1, and may be considered a master standard for this purpose. The tram bar shown may be made of 2-in. by ½-in. steel about 8 ft. long. Hardened steel bushings about ¼ in. in outside diameter with a 1/16-in. hole drilled in the center about ¼ in. deep are set in this bar at proper locations. These are used as gage points when setting adjustable trams. At A is shown the zero bushing that is always used as one of the setting points; the remaining bushings as shown at *B, C,* etc., are located a distance from the zero point equal to the standard distance, center to center, of rod sections. The class of locomotive and rod section are stamped on the bar near the bushings for the purpose of indicating them. For example, if locomotives known as 2-8-2-A require a distance of 54 in. for the front section of the rod, the bar is stamped "2-8-2-A FRONT" at this place. Another for an intermediate section may be distant 58 in. and stamped "2-8-2-A INT.," and so on.

These bars are permanently fastened on walls, benches or other convenient locations in the erecting shop and rod shop.

* This is the final of a series of three articles. For the preceding articles, see the *Railway Mechanical Engineer* for August, page 481, and September, page 553.

The men, when setting adjustable trams, go to these locations and set the points of the trams to the holes in the bushings. Two or three will generally meet the requirements.

These tram bars afford ready and accurate means for setting the adjustable trams and also remove many possibilities of errors when laying off rods, shoes and wedges, or axle centers, because both the erecting and rod shops are working to the same standards. In case of an error, they are referred to as a master standard.

Measuring Side Rod Bushings

Micrometers calipers have proved very satisfactory for measuring the diameter of crank pins, the bore of side rods and both the outside and inside of rod bushings. In several shops it is the practice to measure the diameter of crank pins with micrometers both for the purpose of judging as to the necessity of refinishing and also to obtain the required size for boring the side rod brasses. This work is performed at the same time and in a manner similar to that of inspecting driver axles. The diameters or crank pins are, at this time, recorded on blanks and handed to the workmen whose duties are to bore the rod brasses. When boring the brasses, they are made a predetermined amount larger than the crank pins to allow for the required running fit between the two, and, while no definite amount is recommended, it is believed that the brasses should be about .002 in. per inch of diameter larger than the crank pins when the latter, if out of round, are measured at their largest diameter. Thus, for a 6-in. crank pin, the brass should be bored 6.012 in.; for a 7-in. crank pin the brass should be bored 7.014 in. etc. The use of micrometers which tend to insure accurate measurements combined with the records of road service will, in time, supply data from which the amount that should be allowed for a running fit between the pin and brass can be decided for all classes of power.

The more progressive method of boring rod brasses either before or after forcing into rods is to make use of adjustable boring bars equipped with micrometer dials similar to those described in connection with boring car wheels. Where the crank pin sizes are recorded in decimals on blanks the man finishing the brasses bores them a specified amount larger than the pins and, as a result, need not leave his station for the purpose of taking sizes of crank pins. This results in a greater output of the machine and also the blanks become a record which, in the event of an error or a defective bearing, may be referred to. If the defective bearing is due to a man failure the blame can be placed where it belongs, or if the road records are not satisfactory, the amount that should be allowed for a running fit can be modified. This tends to solve the troublesome question as to the amount that should be allowed for a running fit. The use of micrometers will gradually reduce this question to an exact science and result in the elimination of the personal equation such as follows when measuring crank pins with machinists' calipers. One of the greatest advantages from the use of micrometers follows when men, unaccustomed to this work, are called upon to bore rod brasses from printed instructions which specify the amount the brasses should be larger than the pins. The possibilities of errors are reduced to that of machine work or measuring, thus eliminating the necessity of a new man estimating the amount that should be allowed.

The inside micrometers similar to that used for car wheels are very satisfactory for measuring the diameter of the bore of side rods. By their use the rod bore is quickly measured at different angles, and in the event of the bore being out of round an excessive amount, the rods can be set aside for reboring. If the average diameter is found to be within the required limits, the outside of the rod brass is turned a definite number of thousandths of an inch larger than the rod bore. The outside micrometers are used in this operation. When fitting side rod brasses the amount the brasses should be larger than the rod bore can be governed by the use of micrometers by definite instruction which will reduce the possibility of brasses being turned too large and thus straining the rods or, if turned too small, coming loose.

Knuckle Pins and Bushings

Inside and outside micrometers are used to good advantage when fitting side rod knuckle pin bushings. The measuring is similar to that used in connection with fitting side rods brasses.

When fitting pins to knuckle pin bushings, it is generally considered desirable to allow a small amount of lost motion between the two, which may vary from .004 in. to .008 in., according to the class of service, individual judgment, etc. It is important that the lost motion shall not be too small where there would be the possibility of insufficient play to admit of weaving of the joints between the rod sections when the locomotive is rounding curves and likewise not too great

Measuring the Bore of a Side Rod Brass with An Inside Micrometer

an amount which may admit of the rods knocking. Micrometers are used to good advantage when fitting these two parts together. One practice is to measure the bore of the bushings after pressing them in the rods, and then grind or turn the pins the specified amount smaller than the diameter. This practice generally results in quick and accurate fitting. Another practice requiring close measurements is at the time of manufacture to grind the bore of bushings to plug gages and pin bearing surfaces to exact diameters and place in stock. Having the bore of the bushings and the body of the pins finished greatly reduces the time required for repairs. This practice is worthy of serious consideration owing to the economy of production grinding as compared with fitting each part separately. It, however, has certain drawbacks such as the necessity of true and cylindrical holes in the rods into which the bushings are to be pressed owing to any

irregularity of the rod hole being reflected in the bore of the bushing after it has been forced into the rod. A certain allowance must also be made for the compression of bushings when pressing into place.

When fitting with tapered ends of knuckle pins to side rods the flat tapered gage shown in Fig. 2 is of great assistance. It is about ¼ in. thick, accurately ground on the edges to the same taper per foot as the reaming of side rods. One edge is graduated and stamped similar to a rule or scale to indicate the actual diameters at the graduations. When measuring the diameter of a taper hole in side rods or testing the accuracy of the reaming, the gage is placed in the rod as shown and given a slight turn which centers it. The

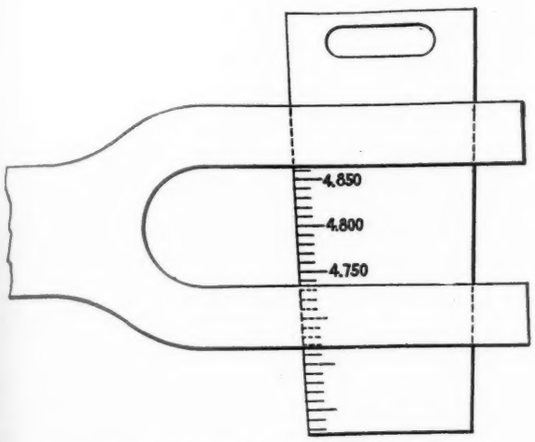


Fig. 2—Taper Gage for Knuckle Pin Holes

diameter is then read at the inside of the smaller jaw. When grinding or turning the knuckle pins, its diameter at this point is finished to the same diameter plus the amount that should be allowed for a drive fit. During this operation the pin is measured with a micrometer as shown in Fig. 3. When this surface of the pin is to the correct size, the in-feed position of the grinding machine or lathe tool is noted or set. The larger end of the pin is then finished from the same setting which makes it evident that with the taper of the grinder or of the lathe properly set, the two ends of the pin will be finished to the required taper per foot, providing the grinder or lathe tool is, in either case, fed in the same amount as would follow were the taper continuous from end to end of the pin.

This gage has the advantage of light weight, ease of application, and acts as a check on the accuracy of the reaming of rod jaws. By its use in connection with micrometers, semi-finished knuckle pins are readily ground on the two taper ends to a rod fit in less than 10 minutes.

Measuring Main and Side Rods

In past years it has been the practice, when fitting in main rod brasses, to file or chip and make several trial fittings of the brasses before they were finished to the correct size. This was considered satisfactory for the light weight brasses formerly used. Today the brasses have become so heavy that the necessity of lifting them several times before a satisfactory fit is obtained should be avoided when possible. What has been said relative to the measuring crank pins and the bore of side rod brasses also applies to the bore of main rod brasses.

In some of the modern railway shops, when fitting either the front or rear main rod brass considerable time is saved by finishing the brass by machining to the correct sizes. In order to accomplish this desired result it is necessary to measure the parts accurately with micrometers. One good practice is to measure the jaw space with inside micrometers such as shown in Fig. 4. When making use of this instrument the base *A* is placed on one jaw, which sets the micrometer square with the jaw. The width of the jaw is then measured simply by turning the micrometer screw. The micrometer is then moved to other locations and measurements read in order to detect such errors as may exist in the width of the jaw.

Just how much variation should be allowed in the distance between the two sides of the jaw or strap of a single rod is an open question. When the jaws are repaired by milling or slotting it is not difficult to true these surfaces so that the measurements will agree within a limit of .003 in. Where the jaws are filed it becomes a question of the amount of time that should be allowed or what is considered good enough to meet the requirements. This method of measuring makes it entirely practical to set limits for the work, and as the measurements are quickly made, the workman, when refinishing the jaw, frequently makes measurements as the work progresses. The effect is that when truing the jaws either on a machine or by filing, he knows the degree of accuracy demanded and finishes accordingly.

After the jaws and the sides of rods are finished in a satisfactory manner, the width of jaw and thickness of the rod is measured and a memorandum made of it for the benefit of the man finishing the rod brasses.

In a number of shops rod brasses are finished on planers, slotters or milling machines to the exact size required to fit the rod jaws which results in the elimination of practically all filing and the laborious operation of making the several trial fits previously mentioned. The practice, when machining, is to finish the surfaces to fit and rod jaws .002 in. or .003 in. less from surface to surface than the jaw opening. The distance between the flanges of the brasses are finished about the same amount wider than the rods. These distances, during the machine operations, are measured with micrometers. To finish rod brasses so that, as they come from the machine, they will fit the rods without hand work requires a high grade of machine work and close measuring. This is difficult to accomplish without the use of micrometers, and while this manner of finishing as compared to semi-

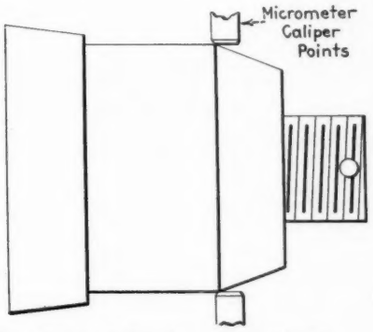


Fig. 3—Calipering a Knuckle Pin

finishing may add to the cost of the machine work, there is a substantial saving as a whole owing to the elimination of hand work. The character of the fit of brasses to the rods is as a general proposition greatly improved.

Gages for Valve Motion Levers

By careful planning and with the proper facilities, the bearing surfaces of pins and bushings such as used in valve motion levers are readily made to interchange with each other, and, as a result, the companion levers for each class may be shifted from one locomotive to another with the assurance that they will fit in a satisfactory manner. As an example, the bushings used in the lap and lead levers for any one class of locomotives are fitted with bushings having their inner bearing surfaces finished to plug gages. The companion

levers are fitted with pins having bearing surfaces which are finished a trifle smaller by the use of external gages or micrometers. In other words, each bearing surface is finished to a gage or micrometer, which, therefore, becomes a substitute for the practice often followed of fitting the pins and bushings to each other for each individual pair of levers. Finishing parts in this manner admits of quantity production where the bearings are finished in large lots. In addition there is a decided saving in time when repairing the levers.

A practice followed in some shops is to bore, ream or grind the internal bearing surfaces of the bushings to plug gage sizes within a limit of .001 in., the outside of the bushings being only rough turned. The external bearing surfaces of the pins are finished to external gages or micrometers to a limit of .001 in. the ends being rough machined. It is, of course, necessary when determining upon the sizes for these bearing surfaces to make allowances for the running fit between the two. Good practice appears to indicate that the allowance for running fit should be between .005 in. and .006 in. In addition, allowances must be made for the compression of the bushing resulting from pressing it in the lever. This compression may possibly amount to .002 in., and under these conditions the pins at the time of finishing should be about .008 in. smaller than the bushings. As an example, for 2-in. bushings, the pins should be 1.992 in. in diameter. It is not within the scope of this article to go into the question of the various step sizes that are necessary to meet all conditions of repaired valve motion levers. The use of plug gages, external gages and micrometers, however, have made it a simple every day proposition in railway shops to finish these bearing surfaces to the limits of accuracy desired.

Fitting Bushings to Valve Motion Levers

At the time of making repairs, the holes for the bushings in valve motion levers generally vary to such an extent that any attempt to make use of bushings previously finished to

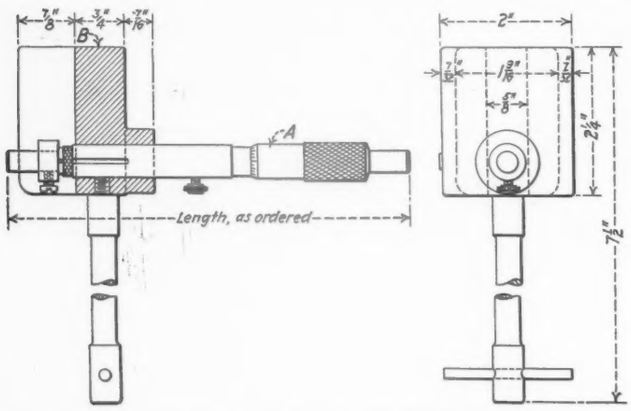


Fig. 4—Inside Micrometer Calipers with Special Attachments for Measuring the Front or Rear Main Rod Jaw Space When Renewing Brasses

pre-determined outside sizes does not appear practical. It is, therefore, necessary to machine each individual bushing for each particular lever, which is best performed on plain cylindrical grinders. The time required for fitting each bushing to the levers is governed to a more or less extent by the time taken when making measurements. To measure the small holes in these levers with inside micrometers or machinist's calipers is a somewhat slow operation. In order to reduce this time, good use has been made of the sliding gage shown in Fig. 5 which is made up of triangles *A* and *B*, held together in a suitable manner. The edges *F F* that fit the bushing are ground to about a 1-inch radius. The projection *C* is to prevent the triangle *B* from entering the hole.

In operation, the gage is placed in the hole, where the projection *C* comes flush with the side of the lever as shown at *D*. The triangle *A* is now moved forward until the gage is tight in the hole. It is evident that under this condition the combined distance over the triangles *A* and *B* or the surfaces *F F* will be the same as the diameter of the hole and that micrometer measurements as shown at *E* will give the true diameter of the hole. With this gage and micrometers, these holes are accurately measured in a few seconds.

When grinding the bushing, their diameter is measured with the same micrometer used on the gage. The practice is to grind the bushing until it shows a true surface, then measure the diameter, this reading showing the reduction in size necessary in order to obtain the desired diameter, i. e.,

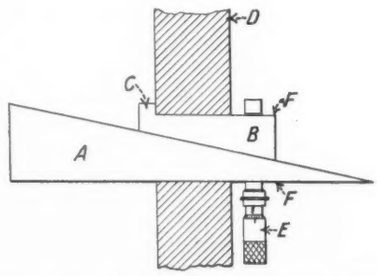


Fig. 5—Sliding Gage Used to Measure Small Holes in Valve Motion Levers

the number of thousandths the wheel must be fed into the work. The amount the wheel is fed is gaged by the micrometer dial on the machine. A person accustomed to the work, after making the first reading, subtracts the desired diameter from this reading and sets the amount on the machine dial and grinds until the bushing is to the correct size, when a final measurement is made. About 90 per cent of the bushings, when ground in this manner, are to the correct size on the first trial. The bushings are generally ground from .002 in. to .003 in. larger than the hole to allow for a forced fit. With this gage, micrometers and a grinding machine, bushings are readily fitted at the rate of 10 per hour, which includes measuring, grinding and driving into place.

The operation of fitting valve motion pins to levers is very similar to fitting knuckle pins to side rods previously explained. The flat gage shown in Fig. 6 is used for obtaining the sizes of the taper holes. The taper end of pins are ground the same as the knuckle pins. An experienced operator will readily fit from eight to ten pins per hour.

Advantages

The use of gages and micrometers has made it possible and entirely practical to finish the bearing surfaces of valve motion lever pins and bushings in the manufacturing department, where, owing to quantity production, the cost is greatly reduced as compared with finishing each of these surfaces separately at the time of fitting to the levers. At this time it is only necessary to grind the external diameter of the bushings and the taper ends of the pins, and as the time required is greatly reduced, one man generally grinds all of the pins and bushings required for a shop repairing 50 locomotives per month.

One of the greatest advantages is the interchangeability of the pins and bushings. As these parts are each finished to the correct size for a running fit to each other, the levers may be mixed up indiscriminately or shifted from one locomotive to another. In some shops it is the practice to repair the levers in large lots and place them on racks. When they are ready to assemble on the locomotive the various levers are picked at random similar to the practice with interchangeable machinery.

Further Proceedings of Master Blacksmiths

Tools and Formers and Method of Spring Repairing which Were Brought Out at the Meeting

THE International Railway Blacksmiths' Association held its twenty-eighth annual convention at the Hotel Sherman, Chicago, August 19, 20 and 21. A partial account of the proceedings, including the list of officers elected for the coming year, appeared in the September issue of the *Railway Mechanical Engineer*. Abstracts of the reports presented on other subjects discussed at the meeting are given below.

Tools and Formers

By C. A. Slenker

Blacksmith Foreman, Long Island, Richmond Hill, N. Y.

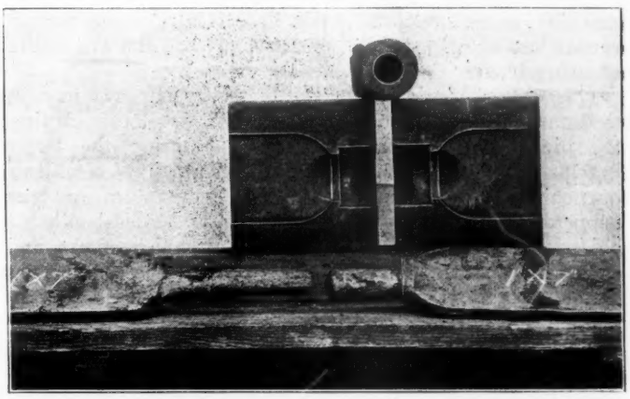
The tool question is an interesting one. Almost every railroad blacksmith shop is to some extent deficient in suitable machinery and the apparent lack of interest in forging machinery and dies is to be regretted. In this direction there is a field for a vast amount of saving in railroad shops.

The question today is economy. Does it pay to make a die for a small lot of standard forgings, about 100 a year? I would say it does. First, it is up to the foreman of the smith shop to form an idea of a suitable die. He must then take into consideration just what the job is costing him at the present time adding overhead expense. He must estimate what the cost will aggregate when using the die. When a foreman has acquainted himself with these facts he will be in a good position to go before his superior and submit the cost of the forging. In nine cases out of ten he will get the dies he is after. Success with forging machine dies depends largely on the ability to design our own dies. Several forging machine companies are sending out plates or drawings of different dies which are a great help to a foreman.

Dies Used in Forging Swing Links

Great improvements have been made in forging machines in recent years. One of the illustrations shows a swing link made of solid stock without welds. This link was made on a two-inch Ajax forging machine. The arrangement of the dies and the number of operations will be evident from a study of the illustrations.

The pitfalls of designing forging machine dies are many. Perhaps the greatest is the attempt to gather too much stock in one upset. If we stay within the laws governing forging machine dies, designing the dies so that not more than three times the diameter of the stock will be gathered we shall have no trouble. The second illustration shows dies for 1-in. by 7-in. driver brake beams. These dies are simple but do a good job which is capable of being organized on a production basis because of the large number of brake beams used in railroad service.



Dies for Making Driver Brake Beams

Improved Method of Repairing Springs

By T. F. Buckley

Blacksmith Foreman, Delaware, Lackawanna & Western, Scranton, Pa.

When a locomotive spring comes to the shop for repairs it is first examined for broken plates and, if apparently sound, it is placed under the testing machine. If it fails to meet the required test the band is removed and the plates are gaged for proper thickness, by a gage 1/32 in. short of size. If the plates show this deterioration they are replaced with new or old steel of the proper thickness. The spring is then reassembled and ready for the spring former.

The furnaces should be equipped with pyrometers to insure exact temperatures for the plates before they go to the machine to be formed. The machine used in forming the plates has an electro-magnet attachment which will not only hold the colder plates but act as a detector for a plate which has not retained the proper temperature between the time it leaves the furnace and the forming machine; the magnet will draw the colder plate back and not allow it to fall into the quenching vat, until it is reheated to the proper temperature.

This improved spring-forming machine is located on top of the quenching vat, and when a plate is formed a section of the table moves down into the oil vat and the plate is tipped off into the oil. The section of the table then raises to its former position. By this new method the time consumed by the plate from the heating furnace to the oil vat

would be approximately fifteen seconds. There is very little loss of heat between the furnace and the quenching vat.

The next improvement applies to the quenching vat, a place where we have not been getting very good results. According to the old method a plate is left in the oil from one to perhaps five minutes, depending entirely upon the judgment of the operator. By the proper system the steel should be left to cool until it is down to normal temperature, 240 deg. F. or less, and not under 90 deg. F.

To accomplish this will take a definite amount of time, depending upon the temperature of the oil. This temperature I would regulate as follows: As the plates are lowered from the forming machine to the quenching vat, a removing conveyor line moves a certain distance each time a plate is formed. By the time a plate is dropped into the oil vat, the movement of this machine controls the removal of the plates from the oil vat, and this takes more time for heavy than for light plates, depending upon the size of the spring to be manufactured. Also with the improved spring forming machine, a section of the table lowers into the oil vat and causes less warping of the plates than with the old method of using tongs.

Quenching Medium: It is necessary that a quenching medium be used of such character as will develop at all times the highest initial hardness, thus permitting the largest drawback to be used. Such an oil should have a uniform quenching speed from atmospheric temperature or room temperature to 250 deg. F. or more. Mineral oils are objectionable due to rapid distillation which alters their quenching speeds. Mineral oils are also objectionable due to the fact that they alter their quenching speeds at varying temperatures of the bath.

The next step in the process is the tempering or drawing of the temper. This is a most important step, because the drawback governs the ductility of the spring. By the old method it was necessary to depend upon the judgment of the operator as to time and temperature. Moreover it was impossible to secure uniform heat at low temperatures.

In order to secure uniform results in the drawbacks, it is now recognized as necessary to have proper furnaces or a liquid bath for this operation. If using furnaces, they should be gaged with pyrometers and also equipped with a traveling hearth at one end so as to speed up the operation and increase production. Plates are placed on this hearth and allowed to pass through the furnace at a certain rate of speed, the time or speed of this table depending upon the size of the steel to be tempered. However, the liquid bath is recognized as giving the most uniform results for this operation. These baths are composed of chemical salts which liquify at temperatures around 200 deg. F. and can be used satisfactorily up to 1,000 deg. F. or more. They can be easily maintained at a uniform, predetermined temperature, and will transfer heat uniformly to the steel very rapidly, thus increasing production.

The next operation is banding the spring. This should be done with hydraulic pressure and the band should be left in the press to cool until it is down to 400 or 500 deg. F.

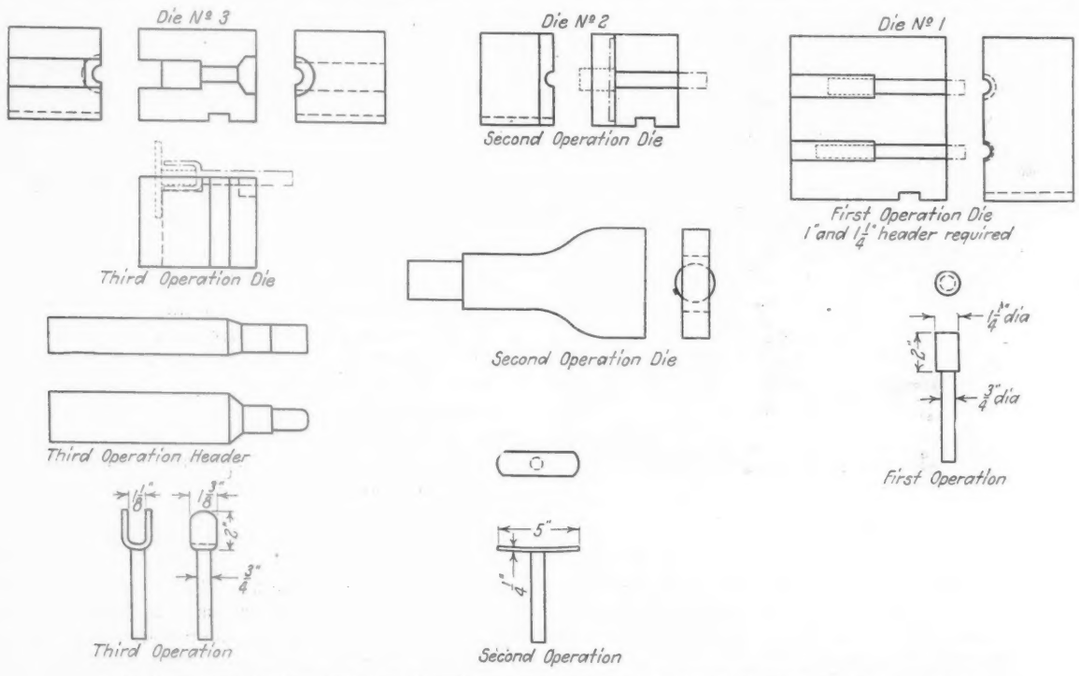
We have found from experience that by refitting 75 per cent and normalizing the steel of repaired springs, we increase the life 100 per cent. To refit all springs by the above improved method would further increase the life of the springs 200 per cent and decrease the cost over the old hand method 75 per cent. The improved forming machine used in conjunction with the cooling and drawing system will produce the serviceable springs required in heavy types of modern locomotives.

Car Stanchion Bracket

By W. J. Mayer

Blacksmith Foreman, Michigan Central, Detroit, Mich.

The attached drawing illustrates the dies used for making mail car stanchion brackets. This bracket is made of three-quarter-inch soft steel eight inches long. The first operation in die No. 1 is a two step upsetting operation of the three-quarter-inch rod to one inch in diameter and one and one-quarter inches diameter on one end. The upset end is then flattened in die No. 2 to ¼ in. by ⅜ in. by 5 in. as shown in the illustration. After this the forging is taken to the punch and the ends cut round on a half-round die. The forging is then formed in die No. 3 to the finished bracket. This is one of the jobs showing the possibilities of the forging machine in railroad blacksmith shop work.



Dies Used for Making Mail Car Stanchion Brackets from ¾ In. Soft Steel Eight Inches Long

Twelfth Annual Convention of Tool Foremen

Meeting at Chicago Notable for Presentation of Many New Jigs and Labor Saving Tools

THE twelfth annual convention of the American Railway Tool Foremen's Association was held at the Hotel Sherman, Chicago, September 3, 4 and 5. The convention was called to order by President G. W. Smith (Chesapeake & Ohio). The principal address by J. A. Anderson, superintendent of shops, Chicago, Milwaukee & St. Paul, was a forceful appeal to the tool foremen on American railroads to make an intensive study of their work with the idea of producing more efficient toolroom methods, jigs and fixtures, thereby enabling locomotive and car repair work to be speeded up and its cost reduced. An abstract of Mr. Anderson's paper follows:

Address by J. A. Anderson

Railroad men are easy to meet, love to talk about their work, and are ever ready to hear the other fellow's side of the story; so much so that in many cases would-be dispensers of knowledge have attempted to point to the railway shops as shining examples of inefficiency. I want to say right here without any apologies that the returns of the railway repair shops of this country will compare favorably with the returns from any other repair industry. The railway shops have done more toward adapting repair work to a production basis than any repair industry I know. This is where the tool foremen have played no small part. The tool foremen of the American railways should feel proud of their achievements. Go to any railroad shop, be it large or small, and you will find ways and methods of doing work to meet the demands, notwithstanding ofttimes lack of equipment.

No sooner does the necessity appear for a new tool, jig, templet, or labor-saving device, be it ever so visionary, than the tool foreman suddenly breaks into the general foreman's office with one more labor-saving device, doing his part towards reducing the cost of transportation. Here is where the Tool Foremen's Association should function. Your year book should be a standard text on jigs and fixtures for railway shop use. I have looked over your proceedings the past few years. While there has been some advancement in this direction, the American Railway Tool Foremen's Association can make itself an authority on railway shop tools.

Your duties as tool foremen are many. Check up and show your respective shop managements how to save money. The items requiring your attention are too numerous to mention such as line shafts out of line; running at slow speeds; pulleys not in use, consuming ⅛ to ⅜ hp. churning air; design and manufacture of forging dies, eliminating hand smithing and reducing the machining time, the field is unlimited; punch press stamping and forming dies (we have not taken the full advantage of the punch press possibilities in railway shops).

Proper selection of belting: This item alone runs into thousands of dollars a year, the service will be improved to say nothing of the money saved.

Grinding material and wheels: The service obtained is dependent on the proper selection as to size, grain, speed and feeds giving due consideration to the design of safety devices.

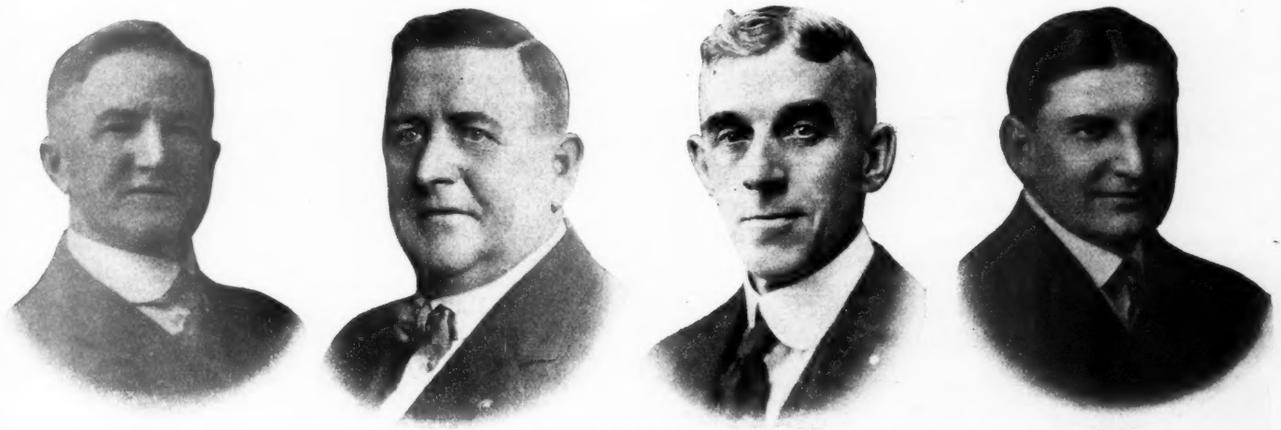
Forging and grinding of tools: Tools improperly prepared increase power consumption at the point of the tool as well as slowing up production.

Designing of jigs and fixtures to do work in accordance with engineering specifications. Study the returns from the various sizes, brands and makers of shop tools, advising your management the tools giving the best returns.

I have in mind a foreman specifying a combination ring gear chuck for work for which it was not suited. This could not happen if all orders for tools originated or were approved by the tool foreman.

While I will not take the time to review the possibilities further, a large part of the tool room foreman's time is taken up in repair work; autogenous welding and cutting equipment, jacks, air hammers and drills. It does not pay to go too far into repair work perpetuating old tools. Analyze each item; set up the repair cost in such a manner as to know what you are getting for money spent.

A new chipping hammer costs $45. Does it pay to repair an old hammer requiring a new barrel at $23? A new barrel means a new piston, $3 extra. By the time you add labor charges, plus overhead, taking into consideration the



G. W. Smith (A. T. & S. F.) President — G. W. Helm (C. M. & St. P.) First Vice-President — George Tothill (B. R. & P.) Second Vice-President — E. A. Hildebrandt (C. C. C. & St. L.) Third Vice-President

$5 credit the manufacturer will allow on the old tool, or possibly keep the good parts for repairs, it is decidedly questionable if it pays to reclaim the old tool.

Just one more thought. Are you using your tool room force to manufacture standard tools that can be purchased cheaper and better in the open market? You may think you are doing the work cheaper, but if all expenses and overhead are taken into consideration, the railroads will not attempt to manufacture standard tools that can be purchased.

We must not overlook the human element. While the tool foreman may not have supervision over a great number of men his influence is felt throughout the shop.

The tool foreman should encourage initiative, offer a word of encouragement where merited, do things to create interest, help make men. After all it is men, real honest-to-goodness men, that are needed in the shops and tool rooms throughout the entire service to make the railways of this country function.

Are you building on a solid foundation? Are you helping to make tool makers? Are you training men to think clearly? Training them to shoulder the responsibilities of the future? If not, you are not doing your full duty as a railway supervisor.

Election of Officers

The following officers were elected for the ensuing year: President, Charles E. Helm, Chicago, Milwaukee & St. Paul, Milwaukee, Wis.; first vice-president, E. A. Hildebrandt, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind.; H. E. Barnes, Southern Pacific, Houston, Tex.; third vice-president, H. P. Jones, Oregon Short Line, Pocatello, Idaho. The association elected as secretary G. G. Macina, Chicago, Milwaukee & St. Paul, Chicago.

Report on Heat Treatment of Steel

By Henry Otto

Atchison, Topeka and Santa Fe, Topeka, Kans.

Papers on the heat treatment of steel have become a permanent feature at our conventions and in our opinion it should be so, for we all know that the above subject is the most vital point in the making of tools.

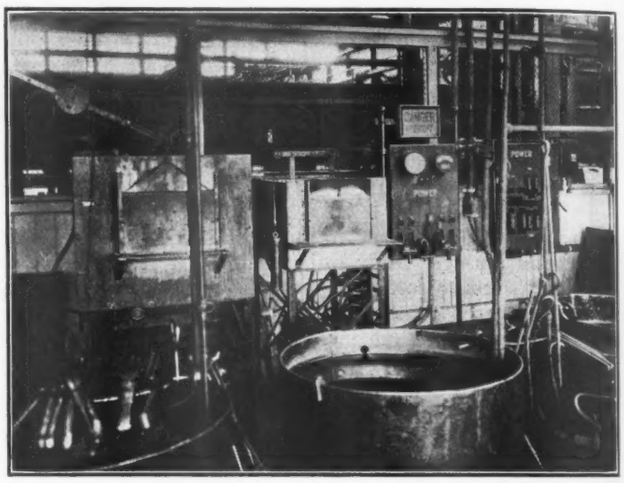
As we progress, new discoveries are made from time to

Gas Furnaces and Quenching Baths

time in steel manufacturing, which necessitate changes in the heat treatment of such steel. The old way of matching colors has been replaced by pyrometers which are more correct in determining the right heat, also eliminating the loss we had, due to over or under heating.

We must at all times study the proper method of heat treating steel, and that is the reason that this subject should be a permanent feature of our conventions. In our 1920 year book we had the most complete report on heat treatment ever submitted to this association by C. A. Shaffer, general inspector of tools of the Illinois Central. This report was both technical and practical and I would suggest to have it reprinted in pamphlet form and furnished to all members of our organization if it be possible to do so, for the benefit of the many new members.

The present paper will deal with the handling of the different tools we are making and their heat treatment in the tool tempering room of the Atchison, Topeka and Santa



Electric Furnaces—Switch and Pyrometer Panels at the Right

Fe Shops at Topeka, Kansas. The equipment installed in the tool tempering room at the Topeka shops is perhaps as complete and up-to-date as that of any railroad shop tempering room in this country. The list of equipment is as follows:

1 Type FC Hoskins electric furnace, temperature 2,500 deg. F.
1 Type FB Hoskins electric furnace, temperature 2,000 deg. F.
1 General Electric heated oil drawing bath.
2 Gas furnaces, made by the American Gas Furnace Company.
1 Open gas furnace, home made.
1 Lead pot furnace, home made.
1 Water quenching bath, home made.
2 Oil quenching baths, home made.

Hardening and Tempering H. S. Steel Tools

The following method relates to flange tools or wheel contour finishing tools, flue hole cutters, flue hole reamers, boilermaker countersinks, 60 deg. axle center countersinks, helical cutters, various milling cutters, etc.

We preheat these tools in the Type FB electric furnace up to 1700 deg. Fahrenheit, leave them in the furnace for about twenty minutes, then transfer them to the Type FC furnace, which has been heated to 2250 deg. Fahrenheit. We leave the tools according to size from 1½ to 3 minutes in this high heat, then drop them in the oil quenching bath, after which they are cooled in the oil, taken out and temper drawn to suit.

In the above way we do all our high speed tool hardening and tempering, preheating tools to the same temperature (1700 deg. F.) but the high temperature is applied according to the size of the tools. It is the high temperature when the tool is left too long in the furnace, that causes trouble. If left too long, the tools will crack in quenching them. Here is where the tool hardener must watch his work closely.

All small high speed tools such as inserted blades for milling cutters, journal box cutter blades, bolt cutting and threading dies, etc., are hardened in a home-made gas

furnace. We do not put them in the electric furnace because of their smallness, they being more easily handled in the gas furnace.

Heat Treatment of Alloy Steel

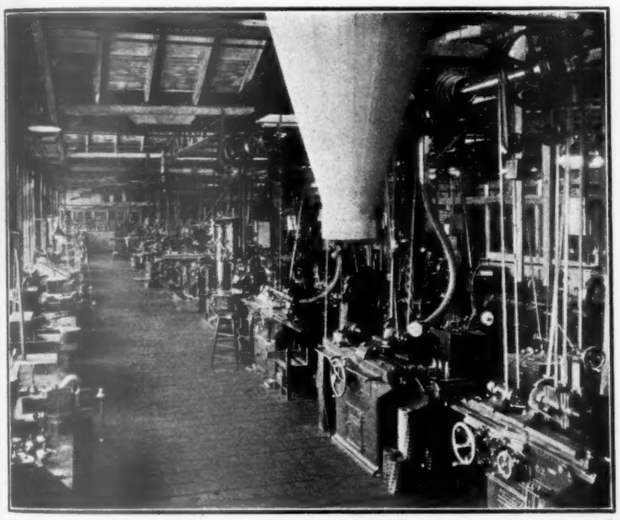
The following is our practice in heat treating scale pivots made of special alloy steel:

From ½ in. thick to 1¼ in. wide, quenching heat 1,450 to 1,525 deg. F.
From 1¼ in. thick to 1½ in. wide, quenching heat 1,550 to 1,575 deg. F.
From 1½ in. thick to 2 in. wide, quenching heat 1,575 to 1,600 deg. F.

All of the sizes of pivots shown should remain in the electric furnace twenty minutes and then quenched in a Signal oil bath, the Signal oil should be heated to 200 deg. Fahrenheit before quenching them, when cold remove them and draw in electric oil drawing bath to 430 deg. Fahrenheit and leave them in the drawing bath with above mentioned heat for fifteen minutes.

Heat Treatment of Carbon Steel Tools

Heat carbon steel tools in the electric furnace to 1400 deg. F. Then quench in water, but be careful not to use the quenching water too cold. It is better to heat the water to



Toolroom at the Atchison, Topeka & Santa Fe Shops, Topeka, Kan.

100 or 110 deg. F. before quenching the tools. If water is too cold it will cool the surface of the tool too quickly and will form cracks on the tool. After the tools are cooled in the quenching bath, clean them and draw the temper in the electric heated oil bath, to the degree to suit the kind of work they are to do. There is a little difference in the heating of carbon steel. High carbon tool steel should not be heated over 1400 deg. F.; lower carbon steel should be heated up to 1475 deg. F., before quenching.

Having electric equipment it is a simple matter to harden and temper carbon tool steel correctly. There is no guess work because all heats are measured by pyrometers and thermometers, which with careful checking do not fail. I have not lost any tools during the operation of heat treating since we have installed electric furnaces and electric heated drawing baths. I have been using them since March, 1917. I want to impress too, every member of our organization who has made any amount of tools for his company with the importance of electrical equipment for this class of work and suggest they take it up with their superior officers to get this up-to-date equipment.

It is certainly annoying to the tool room foreman when he has made a new tool at great cost to send it to the blacksmith shop and then have it spoiled in the heat treatment. There is a great saving for any company to have up-to-date equipment for heat treating steels under the supervision of the tool room foreman.

Don'ts in the Heat Treatment of Steels

Don't preheat your high speed tools too fast, but let the heat penetrate through. It will give you the best results in high heat.

Don't let your high speed steel tools soak too long in the high heat before quenching, or you will lose them.

Don't overheat your carbon steel tools; if so, do not quench them, but lay them in a dark place until cooled off and then bring them to the right heat and quench them. In doing this you will save the tool.

Don't have any visitors in your tempering room during the heat treating of tools or you may spoil your work.

Don't quench your tools in water, unless you know it has the right temperature. Put your thermometer in the water and see that the water is not too cold; cold water will crack the tools.

Don't take the tools out of the quenching bath until they are cooled off; removing them when hot will cause them to crack in the open air.

Don't take the tools out of the drawing bath too quickly but give them time to get the right temper before removing.

Don't think of other things when you watch your heats, but have your mind on your work. This is more important to you; right thinking means money to your employer.

Don't do any work or use any methods by which you endanger yourself or your fellow worker. Safety first should be your permanent way of doing work.

Don't think you know it all, but listen to good advice given by your steel agent in regard to handling his steel. He represents the maker of the steel and knows more about the heat treatment of the steel than you do. If in practice you find something better than he told you, let him know the good news and he will pass it on to others who are using his steel.

[Other papers read at the convention will be abstracted in subsequent issues of the *Railway Mechanical Engineer*.—EDITOR.]

Every Detail Harmonizes Perfectly and Adds to the Colonial Atmosphere of the New B. & O. Diners

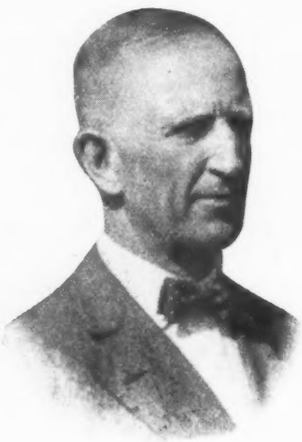
A Group of Members and Guests at the Convention of the Equipment Painting Section, A. R. A.

Master Painters Hold Convention at Chicago

"The Protection of Steel in Freight and Passenger Equipment from Corrosion Is of Vital Importance"

THE Equipment Painting Section of the Mechanical Division of the American Railway Association held its third annual meeting at the Hotel Sherman, Chicago, on September 2, 3 and 4. R. H. Aishton, president of the American Railway Association, was to have delivered the opening address but could not be present. W. E. Dunham, superintendent of the car department of the Chicago & North Western, spoke in part as follows:

F. W. Bowers
Chairman



A. E. Green
First Vice-Chairman

James Gratton
Second Vice-Chairman

Address by W. E. Dunham

"This is the age of the specialist, and the painter of railway equipment must be a specialist in every sense of the word if he expects to meet properly the situation confronting him. Being a specialist does not anticipate narrowness of vision on his part. Narrowness makes for crankiness and that is exactly what we do not need or want. The protection of steel in freight and passenger equipment from corrosion is of vital importance to railroads now and is becoming more important every day. The master painters should go on record in a straightforward, two-fisted manner as to what must be done with this steel from the time it is made ready, piece by piece, for erecting, until the car is completed, to stop the fearful waste that rust is causing. With such experience as you and others have had since the first steel cars were made, and with your knowledge of present-day shop practices, this can and will be done." Mr. Dunham went on record as favoring a committee report on shop and maintenance practice to be used by members of the section as recommended practice. He also spoke at some length on the necessity of encouraging railroad employees to be loyal, especially at the present time when so much social and financial unrest is prevalent, and when a constant stream of cure all plans is being presented by men whose chief claim to recognition is "loudness of voice or the astuteness of their press agents."

New Officers Elected

The following new officers were elected: chairman, F. W. Bowers, foreman painter, Erie, Kent, Ohio; first vice-chairman, A. E. Green, foreman painter, Chicago & North Western, Chicago; and second vice-chairman, James Gratton, general foreman painter, Buffalo, Rochester & Pittsburgh, Dubois, Pa. In addition to the three officers mentioned the following have been elected members of the Committee of Direction: H. C. Allehoff, foreman painter, Oregon-Wash-

ington Railroad & Navigation Company, Portland, Ore.; W. Mollendorf, foreman painter, Illinois Central, Chicago; J. McCarthy, foreman painter, Canadian National, Montreal, Que.; H. Hengeveld, master painter, Atlantic Coast Line, Waycross, Ga.; F. E. Long, foreman painter, Chicago, Burlington & Quincy, Aurora, Ill.; J. W. Gibbons, general foreman locomotive painter, Atchison, Topeka & Santa Fe, Topeka, Kans.; J. F. Gearhart, foreman painter, Pennsylvania, Altoona, Pa.; and B. E. Miller, master painter, Delaware, Lackawanna & Western, Kingsland, N. J.

Economy in Painting Railway Equipment

By J. W. Gibbons

General Foreman Locomotive Painter, Atchison, Topeka & Santa Fe

For years past, the thought has been expressed that all trades or crafts, except the painters, have advanced in methods of doing work by machinery so that they have been enabled to meet the demands of civilized society at a price

Fig. 1—Surface of a Steel Car in Service So Long that the Paint Had Checked and Cracked—Photographed After Sandblasting, Showing Where Corrosion Had Eaten Into the Surface of the Metal

within the reach of even the humblest citizen. It has been the boast of the unthinking painter that his craft is still doing work with practically the same tools that were in use one hundred years ago. To the thoughtful workman, this brought the realization that an art or craft that did not progress would surely die. He has been compelled to see all ornamentation removed, piece by piece, from both the exterior and interior of railway equipment, as well as to see the surface applied reduced to the lowest possible number of coats that will retain a surface that can be easily cleaned and present a fair general appearance. Even this is threatened and some railroads are giving their passenger cars and locomotives but little better paint treatment than the average railroad gives its freight cars. This has brought about a condition that makes it practically impossible to get good, intelligent apprentices for the trade. Personally, I believe that we have gone as far as, if not farther, along this line than good service and proper sanitation permit.

Paint Spraying Devices the Remedy

It is inconceivable that the public that demands and obtains cleanliness, neatness and ornamentation in and around their homes, are going to patronize a railroad that permits the general appearance and sanitary condition of its equipment to further depreciate. The remedy at hand to obtain the desired economy without further depreciation is the installa-

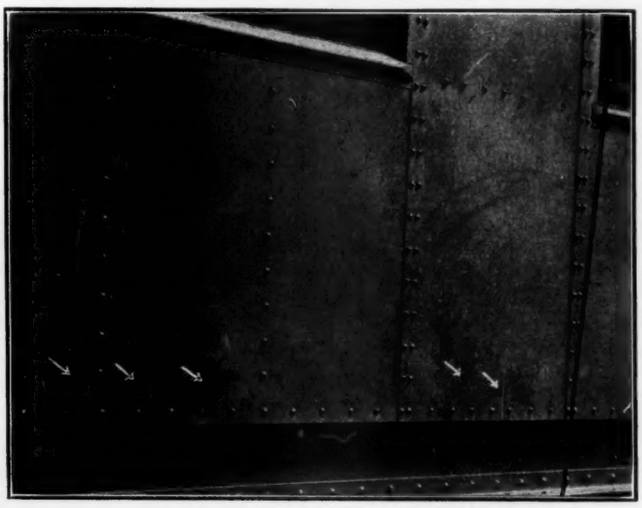


Fig. 2—Holes Eaten Through Steel Dining Car Due to Lack of Proper Paint Protection on the Inside of the Sheets

tion of spraying devices that will apply paint at the lowest possible cost and still maintain the appearance and protection necessary.

Machinery has really promoted efficiency and increased the demand for men of the crafts where they have adapted themselves to new conditions. It will do the same for the painters' trade, if the men apply themselves and assist in improving the machines and thus keep the cost of ornamentation and paint protection within the reach of all.

It certainly is false economy to purchase paint, varnish and enamels on price only, regardless of durability, appearance, working qualities or covering power. That this has been done by the purchasing departments on some roads has been charged in past conventions of this association, without any apparent effect. This discourages the loyal, intelligent foreman and the company does not get the service it should, either from the men employed, or material purchased. From time to time, committees of this association have reported upon the advisability of purchasing paints by specifications.

Regarding Railroad Specifications

Recently my attention was called to a case where a certain railroad was buying a paint upon specification of its own and the manufacturer called their attention to the fact that he could give them a better grade of paint for $5.00 less per cwt. than they were paying for the paint bought on specifications, and he submitted an analysis of their product in proof thereof. This was checked up and their claim was substantiated and they were given the business. This is true economy; but how many thousands of dollars are lost by the railroads continuing to follow a discredited practice.

The question is asked, "But how are we to protect our com-

panies from deception and substitution of inferior material?" We have frequently pointed out that after practical and film tests have demonstrated the quality of a material, analysis of same should be made and any time a question is raised as to a quality, they should be checked up to determine whether materials have been maintained like the original shipment.

The photographs, Figs. 1 and 2, demonstrate the great deterioration that occurs when steel is not properly protected.

Fig. 1 is picture of car that had been in service for several years without paint treatment. The old paint and varnish surface was checked and cracked and when old paint was sandblasted off, it was found that the rust had eaten into the surface of the steel where it had been exposed to weather, as clearly as if it had been etched with acid. Is this economy?

Fig. 2 is picture of a dining car where moisture penetrated. A few cents were saved on original cost that has run into dollars and several days' time to repair damages, and yet we find in a very large per cent of railroad shops, the foreman painter has nothing to say as to the material he shall use or the methods used in applying them. Under these conditions, is it any wonder that in traveling over the country, we see railroad equipment that has cost millions of dollars to purchase and maintain, deteriorating rapidly by corrosion or decay, due to lack of paint protection.

Therefore, in defining what "Economy in Railroad Painting" means, I would say the exercise of the same good business sense that is exercised in the management of other railroad departments. *Employ competent supervisors* and give them sufficient authority to bring about the desired results.

Shop Construction and Equipment

At the meeting of the committee it was the opinion of those present, that the subject assigned them, "How must the paint shop be equipped to make it practical for the use of paint sprays"; presented a phase of paint spraying that very few of our roads have taken up, especially the spraying of passenger car bodies.

The committee fully realizes the importance of this subject and the fact that the members all will, sooner or later, be called upon by their various roads to ascertain the advisability of the use of the paint spray for the application of the various coats of paint and varnish to the exterior and interior of passenger equipment.

It is well known that the objectionable features of the spraying of paint inside of shop buildings are the fumes and mist that arise from the operation which greatly endanger the health of all those whose duties require their presence in the immediate locality, also the damage caused by the settling of this mist upon other equipment. It would seem then, this would be the greatest problem to overcome along the lines of shop equipment to successfully handle this work.

You all, no doubt, are familiar with the methods in use to overcome this objectionable feature by the various industries who are successfully using the spray for finishing small articles. These devices, however, would not be practical for passenger car spraying, except for removable parts.

A great deal of thought, time and money have been expended by various concerns in the improvement of paint spraying devices, and great improvements have been made over the crude devices a great many of us have experimented with in the past, and it has been brought to the attention of this committee that at least one firm claims to have perfected a device that will eliminate the mist and vapor that has made paint spraying so objectionable in the past. Your committee, would suggest this subject be carried over for further investigation.

The report was signed by J. F. Gearhart (Chairman), foreman painter, Pennsylvania; A. J. Bishop, foreman painter, Northern Pacific; A. H. F. Phillips, foreman painter, New York, Ontario and Western; E. B. Stair, master car painter, Atlanta and West Point; B. D. Mason, master painter, Colorado and Southern.

Removing Paint, Varnish and Corrosion

Your special committee on removing paint, varnish and corrosion respectfully submit the following report on the several subjects assigned it:

1. What is the best and most practical method of removing paint and varnish from the exterior of passenger cars where sand blast is not available?

Ans. Reiterating former reports made to conventions of this association, we desire to emphasize the fact that sandblasting is the best and most economical method of removing paint, varnish or corrosion from exterior or interior of steel equipment and we desire to state that in our opinion sandblast facilities are available to all who desire to use them. However, pending the installation of sandblasting facilities the following methods are available.

1st. Burning with special arranged torch and proper gas. This method cannot be used economically on a surface constructed of heavy steel plate on account of the amount of gas required to heat to a blistering temperature.

2nd. Varnish removers are the best and most economical. The great objection to their use, outside of the time required to remove the paint, is their inflammability, which greatly enhances the danger of fire hazard and increases cost of insurance.

3rd. The old lime and lye method is available although some of the enamels used in finishing railroad equipment are not as easily removed with it as the flat color and varnish system. Another objection to its use is the fact that water must be used freely on the surface to remove all trace of the lye. In all cases where the lime and lye method is used, after the surface has been thoroughly washed with water and dried, it should be washed with a mixture of 1/3 vinegar, 1/3 raw linseed oil, 1/3 turpentine and wiped off with dry waste.

2. Is it practical to sand blast the exterior of steel coal cars before painting?

Ans. It is practical and the most economical method known.

3. What is the next best method of cleaning rust and scale off of steel freight cars when sandblasting is not available?

Ans. The pneumatic hammer and chisel and revolving steel brush are the most practical and economical for the above purpose where sandblast is not available.

4. Are the modern pneumatic brushes and tools now being introduced on the market desirable and economical when compared with other devices for cleaning rust and scale off of steel equipment when compressed air is available for the use?

Ans. The answer to Question No. 3 will cover Question No. 4.

The report was signed by J. W. Gibbons (Chairman), general foreman, locomotive paint, Atchison, Topeka & Santa Fe; G. J. Lehman, foreman painter, Chicago & Eastern Illinois; James Gratton, general foreman painter, Buffalo, Rochester & Pittsburgh.

Discussion

The discussion of this report was not extensive but indicated beyond doubt that the great majority of members were strongly in favor of sand blasting as the most rapid, economical and satisfactory method of removing paint, varnish and corrosion from steel cars before painting. Discussion brought out the opinion that where foremen painters are sufficiently convinced of the merits of sand blasting, they are in a position to submit adequate evidence to their superiors to insure the necessary sand blasting house and equipment being supplied.

Report on Standards—Car and Locomotive

Your committee was assigned several subjects for investigation and report during the year.

What success, if any, has been obtained to prevent paint peeling from galvanized iron car roofs? It is the unanimous opinion of your committee that as applied to galvanized iron in car roofs it is primarily for appearance and that the galvanizing without paint should protect the iron approximately the same length of time as the paint. Appearance, however, is an important factor in passenger equipment cars. Your committee has carefully considered the following methods of painting galvanized iron roofs on passenger equipment cars and will, during the coming year, conduct tests of each of these methods and report more definitely to you at the next meeting of the Section:

(1) Princess mineral thinned with oil and colored to suit —one coat.

(2) Slush varnish and mineral mixed for primer and one coat of color—two coats.

(3) Slush varnish for primer and one coat of standard roof paint—two coats.

(4) Sand blasted lightly, one coat of red lead (U. S. Government formula), two coats of standard roof paint—three coats.

It is the opinion of your committee that the painting of new galvanized iron roofs of freight cars is only a matter of appearance, therefore, your committee recommends that such roofs be run for at least one year before painting. When painted it is the belief that any kind of paint used on freight car bodies should be satisfactory.

What is the most practical and economical method of bringing up interior of passenger coaches for graining or coloring? The committee believes that the members should give most earnest consideration to the economies made possible by reducing the number of coats applied to both exterior and interior in painting of steel passenger cars. The committee will keep in close touch with this subject during the year and report further at the next meeting of the Section. It is the consensus of opinion of the committee that railroads are applying too many coats of paint and materials to steel passenger cars to the detriment of the material being protected. The members are also requested to give earnest consideration to the savings possible by eliminating all or a large portion of the rubbing now practiced on certain roads in connection with a reduction in the number of coats of paint or other material applied.

Advisability of using flat tone finishes for interior of passenger cars instead of gloss finish. It is the opinion of your committee that it is impractical to use what is known as flat tone finish for the interior of passenger cars as it will not stand cleaning and will cause trouble in repainting the car, as flat tone finishes usually have a certain amount of wax incorporated therein.

Should canvas roofs of passenger cars be painted at each shopping? It is the opinion of your committee that it is a good practice to give a light or thin coat of paint to canvas roofs of passenger cars when shopped. While this is perhaps unnecessary it gives the car a better and more finished appearance. It is not considered proper to apply too much thick paint to these roofs as it has a tendency to break and this does the opposite of what is intended.

What parts of a locomotive should be varnished? It is the opinion of your committee that locomotive cabs, sand boxes and tenders should be varnished if it is desired to keep them clean under all conditions.

Does it pay to protect steel underframes, brake beams, air brake rigging and trucks of freight cars with paint? It is the opinion of your committee that steel underframe should be painted each time car is painted but so far as trucks and brake rigging are concerned it is principally a question of appearance.

In addition to the foregoing your committee had referred to it the following question:

What is the most economic and practical material for passenger car headlinings?

The report was signed by A. E. Green (chairman), foreman painter, Chicago and North Western; G. H. Lehnen, foreman painter, Chicago and Eastern Illinois; F. E. Long, foreman painter, Chicago, Burlington and Quincy; J. N. Voerge, general master painter, Canadian Pacific; James Gratton, general foreman painter, Buffalo, Rochester and Pittsburgh; D. C. Sherwood, foreman painter, Car Department, New York Central; John Cook, foreman paint department, Pullman Company.

Discussion

One of the most important points brought out in the entire convention was discussed following the reading of this paper and related to the possibilities of economy by reducing the number of coats applied when railroad equipment, particularly passenger cars, is painted. Some railroads apply as many as 10 or more coats from the primer to the last coat of varnish and what this means in labor cost, material cost and time required for putting the equipment through the shops, can be readily appreciated. At least one road applies only four coats and secures results which are apparently entirely satisfactory, both in protection of the steel equipment and in appearance. The entire matter was summarized by one member briefly as follows: The object of painting equipment is to protect it and give it the desired finish. Four coats will give the desired protection and in fact in some cases may offer greater protection than a larger number of coats owing to the greater elasticity and durability. The kind of finish required, however, is dependent on railroad standards and what each road believes that the public requires. As a rule, the public is a far less keen and critical observer than the foreman painter and in all probability many railroads would be able to reduce the number of coats applied in painting passenger equipment without making any difference whatever which would be discernible to the average observer. If a railroad has some "finicky" higher officer who demands a degree of finish on passenger equipment superior to a good average finish, it follows that the extra coats must be applied and the railroad stand the cost.

Report of Committee on Tests

Your committee has had the following subjects referred to it for investigation and report:

(1) What pigments are suitable substitutes for white lead?

(2) Specifications for white lead?

(3) What pigments are the most suitable for the protection of metal surfaces on railway equipment?

In trying to arrive at a satisfactory solution of the first problem it is well to enumerate the various whites in use. White lead in general use is a carbonate of lead prepared by submitting lead to the action of acetates. It is poisonous, especially when mixed with turpentine or substitutes. The chief adulterations are barytes and whiting.

Carbonate of barytes is less poisonous than lead. It is not as valuable and has very little body. It is whiter and when used in proper proportion makes a very good white and does not injure the lead for ordinary purposes.

Zinc white is an oxide of zinc. It is a durable and beautiful white and is harmless. Some of the finest work is finished with zinc. It has less body than lead, but is vastly whiter and does not turn yellow when excluded from the light and air.

China white is lead that has been washed, thereby freeing it from impurities.

There are various other whites on the market, such as

pearl white, which is generally used for the finer and more delicate branches of painting.

There is also a silver white which is similar to china white as is largely used for tube colors.

There are various whites which are all serving good purposes along special lines. It is the opinion of your committee, however, that a suitable substitute for white lead, one that will answer all the requirements of a pure white lead, has not yet been developed.

For substitution of other materials for white lead intended to give protection under the usual exposure conditions, particularly metal surfaces, where color is not important, the following table is submitted.

AVERAGE RATINGS OF PIGMENTS

The rating of 10 indicates maximum value as a Rust-Inhibitor

No.	Pigment	1910	1914
4.	Sublimed white lead	9.5	3.5
5.	Sublimed blue lead	9.6	6.0
9.	Orange mineral	9.0	3.0
10.	Red lead	8.8	4.0
12.	Bright red oxide	9.3	2.5
14.	Venetian red	7.2	1.5
15.	Metallic brown	6.3	3.0
16.	Natural graphite	9.1	4.0
17.	Artificial graphite	7.1	0.0
19.	Lamp black	7.1	0.0
20.	Willow charcoal	8.8	4.5
21.	Carbon black	8.3	5.0
24.	Yellow ochre	5.8	1.5
34.	*American vermilion	9.1	7.5
36.	Medium chrome yellow	7.0	3.5
39.	Zinc chromate	9.4	4.0
40.	Zinc and barium chromate	9.7	2.5
41.	Chrome green	9.8	5.0
44.	Prussian blue (water simulative)	9.2	3.5
49.	Zinc and lead chromate	9.5	4.0
51.	Magnetic black oxide	9.5	4.0

*Note—No. 34, American vermilion (basic lead chromate) is given the highest rating as a rust inhibitor.

Exhibits will be submitted at the meeting demonstrating the effect of the different pigments used in the manufacture of leads and paints showing the action of each in twelve and twenty-four hour periods.

Specifications for White Lead.

It is the recommendation of your committee that white lead furnished by the manufacturers for railway equipment painting be made in accordance with the A. R. A. Mechanical Division Specifications, as shown on Pages 105 and 106 of the Manual of that Division, in order to insure purity and wearing results.

Pigments most suitable to protect metal surfaces.

Paints for metal surfaces have different functions, in many respects, to those for wood. In painting metal there is not the absorption into the pores, except to an extremely limited extent, as compared to wood. For this reason there must be some other way for getting the strong clinging effect that the pores of wood afford as an anchorage. Once the priming coat is well anchored, the subsequent coats, if properly made and well applied, anchor themselves one on the other, finally depending for their adherence on the fastness of the priming coat and the strength and elasticity of the paint film.

It has been established that the fewer number of paint coats on metal, which will give the maximum protection, the longer wearing and better service will the paint coating give. Considerable experience has been had by the members during the past few years in reducing the number of coats applied to steel passenger cars and the economies in this connection should not be overlooked, but the aim of the painter should always be to give the maximum of protection to the steel painted with the least amount of material and labor.

Proper Preparation of Surfaces of First Importance

No matter what pigments or vehicles are used of the first importance is properly preparing the surface for painting. This subject will be discussed at this meeting in another paper.

Your committee is not prepared to make a unanimous report on the best pigment for protecting steel railway equipment and, therefore, will confine its report to those pigments which in its long experience have been used most successfully.

A panel will be shown to demonstrate the results of painting with red oxide as a pigment ground very fine.

Some members of your committee recommend the use of pure red lead or chromate primer.

For painting freight cars some members recommend pure red lead ground in linseed oil as a priming coat, followed by two coats of carbon black.

The general consensus of opinion of your committee is that lead pigments, carbon black and lamp black are the most suitable pigments for the protection of metal surfaces on railway equipment.

Test plates will be exhibited demonstrating the different methods of painting metal surfaces and to show the results obtained with the various pigments being used for this purpose.

The report was signed by John McDowell (chairman), foreman painter, Chicago, Rock Island and Pacific; J. W. Gibbons, general foreman locomotive painting, Atchison, Topeka & Santa Fe; H. Hengeveld, master painter, Atlantic Coast Line; B. E. Miller, master painter, Delaware, Lackawanna & Western; J. McCarthy, foreman painter, Canadian National; Marceau Thierry, foreman paint shop, Norfolk & Western; H. C. Allohoff, foreman painter, Oregon-Washington Railroad & Navigation Company; G. M. Hoefler, master painter, American Locomotive Company.

Care of Paint and Varnish at Terminals

Engines

Cleaning Frequency. Passenger and freight engines are to be cleaned before every trip, and switch engines at least once a day.

Cleaning Method. Before an engine is run into a roundhouse it is to be run over a rack and a washing machine used, where available, to clean the drivers, trucks, frame, spring rigging and the tender trucks. Where washing machine is not available it is recommended these parts be wiped clean with waste and kerosene.

The jackets, cab and tender tank are to be wiped. The wiping is to consist of the use of waste and a half and half mixture of kerosene and paraffine oil, or a renovator. This is to be followed by a dry wiping with waste.

Care of Front End. The front end is to be given care by the application of a suitable front end paint. Whenever there is an accumulation of paint, and the paint shows a tendency to scale, it is to be cleaned off to the bare iron and finished before the engine is put into service.

Painting Frequency. Passenger engines are to be painted once every nine (9) months, freight engines once every twelve (12) months and switch engines every fifteen (15) months.

Painting Facilities. When engines are painted in enginehouses, the rough work is to be done in the enginehouse, and the finishing coats of paint and varnish are to be applied in stalls partitioned off for this purpose. The painting stalls should be properly heated, ventilated, lighted, and free from dust.

Passenger Train Cars—Exterior Cleaning

Daily Cleaning. The exterior body is to be washed off with cold water before leaving its terminal.

Periodical Washing. The body of a car that is in main line service, and in a first class train, is to be washed off with a solution of oxalic acid every 30 days, and when the condition of the body demands it. The solution is to be applied luke-warm (not hot) and thoroughly brushed, after which the body is to be washed off with cold water from a hose, particular care being given to the removal of dirt, grease, and any traces of acid.

The solution of oxalic acid is to be a maximum of 20 pounds to 50 gallons of water. The acid is to be added to

25 gallons (a half barrel) of hot water and stirred until the acid is dissolved. When dissolved, the barrel is to be filled with cold water, and the solution again stirred thoroughly. The solution then being ready to use.

Renovating. The application of renovator is best confined to the better type of cars operating in first class trains. These cars are to be renovated after each periodical washing; the renovating to be done immedately after the car is dry.

To apply the renovator, a handful of waste should be taken and moistened with it, and then applied to the car, care being taken to leave as little as possible on the car. After the renovator has been applied over the varnished surfaces, it is to be carefully wiped dry with clean waste.

Branch Line and Second Class Cars. Branch line and second class train equipment on which no renovator is used, is to be washed with oxalic acid every 60 days. Where renovator is used, the cars are to be washed with oxalic acid and renovated every 90 days.

New and Newly Painted Cars. New and newly painted cars in first class trains should not be washed with oxalic acid until a period of from 15 to 20 days has elapsed.

Trucks. The trucks and underneath rigging on all cars is to be sprayed or wiped with distillate oil. After spraying, the car is to be allowed to make one trip, and upon its return the trucks and underneath rigging is to be washed down with water from a hose.

Avoid Boiler Compounds. Under no circumstances shall boiler compounds, or other solutions be used in an effort to obtain a temporary good appearance for a car, as it will result in the destruction of the varnish.

Passenger Train Cars—Interior Cleaning

Walls and Headlining. The washing of the interior of cars is to be done whenever the conditions demand it. The interior of a coach, sleeper, diner, parlor and other passenger-carrying cars, is to be thoroughly blown with compressed air before being washed.

The headlining, side walls and partition down to the heater pipes, and the seat arms are to be sponged off with a weak solution of soap and water. After the inside of a car is thoroughly washed with this mixture, it is to be rinsed immediately with clean cold water, and wiped dry with a chamois skin.

The soap and water solution is to be mixed as follows: Thoroughly dissolve one (1) pound of vegetable oil soap in a bucket of hot water, adding one (1) pint of this mixture to each bucket of lukewarm water used.

Floors. Floors are to be mopped up. In mopping up floors care is to be taken not to use too much water, nor allow it to remain too long, as floor becomes water soaked and sour, thus giving the car a bad odor. The use of an undue quantity of water also causes damage to steel underframe equipment.

To avoid complaints from passengers about the odor of disinfectant, soap and water are to be used for cleaning floors of passenger cars, except in toilets and floors of baggage and express cars, where one-half (½) pint of disinfectant should be mixed with a twelve (12) quart pail of water.

Vestibules. Inside of vestibules is to be washed with soap and water, and thoroughly dried.

Miscellaneous. Heater pipes, foot rests, seat pedestals are to be cleaned with soap and water when the floors are cleaned.

Milk, Etc., Cars. The cleaning of milk cars, and express cars which are used in the shipments of fish, are to be treated in accordance with the government regulations.

Other Cars. Mail, express and similar cars are to be washed with a soap and water solution whenever their condition demands it.

The report was signed by L. B. Jenson (chairman), shop superintendent car department, Chicago, Milwaukee & St. Paul; W. Mollendorf, foreman painter, Illinois Central; James Gratton, general foreman painter, Buffalo, Rochester and Pittsburgh; F. E. Long, foreman painter, Chicago, Burlington and Quincy; A. J. Allen, foreman painter, Delaware, Lackawanna and Western.

General Foremen Gather for 1924 Convention

Enthusiastic Meeting at Chicago, While Not Largely Attended, Indicates Possibilities of the Association

SOMETHING less than 150 members of the International Railway General Foremen's Association assembled at the Hotel Sherman, Chicago, September 9 to 12, inclusive, and, under the able direction of President G. H. Logan of the Chicago & North Western, held a convention which was an inspiration to all concerned. It is improbable that any general foreman or railroad shop supervisor who attended the convention left it without value received from hearing the addresses, papers and discussions. More than one member commented on the fact that a single new idea received at the convention would often more than pay both himself and his railroad for the trouble and cost involved in sending him. Obviously, the membership of the General Foremen's Association is not nearly as great as it should be and a fixed determination was apparent on the part of the officers and many of the general foremen to corral new members in the coming year and make the International Railway General Foremen's Association the influential body which it ought to be, with a real voice in general matters affecting railroad mechanical departments.

In addition to committee reports, some of which will be abstracted in this and subsequent issues of the *Railway Mechanical Engineer*, the association members listened to an address by H. T. Bentley, general superintendent of motive power and machinery of the Chicago & North Western, President Logan's address and an address entitled, "The Power Plant on Wheels," by L. G. Plant, assistant to the president of the National Boiler Washing Company.

Election of Officers

The following officers were elected for the ensuing year: President, H. E. Warner, shop superintendent, New York Central, Elkhart, Ind.; vice-president, C. A. Barnes, general foreman, Belt Railway of Chicago; second vice-president, F. M. A'Hearn, general foreman, Bessemer & Lake Erie, Greensville, Pa.; third vice-president, W. F. Lauer, general foreman, locomotive department, Illinois Central, Memphis, Tenn. M. R. Benson, general foreman, Michigan Central, St. Thomas, Ont., was elected chairman of the Executive Committee.

Address by H. T. Bentley

Mr. Bentley spoke in part as follows:

So many improvements have taken place in tools, machinery and methods during the past few years that a man who does not read the technical papers and keep up-to-date on the progress made is out of place as a leader of men or to

be in charge of a plant where results obtained are what count.

What is there that you as a general foreman can do to improve the efficiency of your shop? Are you interesting yourself in the education of your apprentices so that they will become good mechanics? A word of advice or encouragement will do a great deal to stimulate the boys' interest.

Are you as full of enthusiasm and ingenuity as you ought to be?

Have you initiative? One man will say it cannot be done, and another will go and do it.

In dealing with your employees treat them as you would like to be treated, but insist on a proper day's work being done. Cultivate a pleasant personality so that the men you come in contact with will work hard for you because they like you and not do so on account of being afraid of you.

Keep records of costs and output of similar machines in such a way that comparisons can be made to justify requests for new tools when you can show in dollars and cents that their purchase will increase the efficiency and decrease unit costs.

We have some shops that are not strictly up-to-date either in tools or equipment, but find that due to the efficiency of the organization, they are getting results that are very gratifying and show up favorably with some of the newer shops. More depends on the organization than the tools and facilities. In other words, I would rather have an old shop with a good organization than a new shop with a poor organization.

The following "leaks" should have prompt attention:

Loafing.
Waste of material.
Machines not working to capacity.
Air, steam and water leaks.
Men waiting for material.
Men having to walk too far for tools and material.
Not starting work promptly.
Washing up before the whistle blows.
Scrap not picked up.
Shops not kept clean.

Thoroughness in doing necessary work to locomotives in shops will probably reduce the shop output somewhat, but materially improve the service and decrease cost of engine-house maintenance. Slovenly and improper work increases failures on the road and is not an economical proposition notwithstanding records of low costs in the shops. With the close checking that is necessary to keep down expenses it is advisable to watch every operation to see that it is done in the most economical manner. It is possible that some of us overlook things of this character that a stranger would see as soon as he came into our shops.

We are anxious to improve our conditions and positions and the best way to accomplish these results is to do things that stand out and bring us in the limelight. There are a large number of foremen who just get by every day and don't seem to have any ambition to get ahead. You can depend upon it that under conditions that exist, they will have to be demoted as a man who cannot go ahead must of necessity fall behind, and I know your organization does not stand for "tail enders."

President Logan's Address

In times of labor trouble, wherein cessation of normal transportation is threatened, press and public become duly cognizant of the vital importance of railroad transportation, but at other times, the press gives considerable space to the speeches of aspiring (not inspiring) politicians who rave and rant at the assumed crookedness of railroad executives and indicate that if the suffering public will but elect them to office, laws will be enacted to revolutionize railroad operations to the mutual benefit of all concerned. To wit: Increased revenue to the government; decreased rates to shippers, farmers and passengers; increased revenue to the individual states; increased compensation to all railroad employees; better working conditions for all railroad employees; better service throughout the country on established lines by reason of extensions, which of course will be made at once; better maintenance of road bed and equipment; greater safety to the public because of track elevation and the placing of gates at all crossings manned by watchmen working in shifts of eight hours; greater safety for railroad passengers and employees through installation of automatic train stopping devices, etc.

G. H. Logan (C. & N. W.)
President

H. E. Warner (N. Y. C.)
First Vice-President

C. A. Barnes (Belt Ry. of Chicago)
Second Vice-President

William Hall (C. & N. W.)
Secretary-Treasurer

The above conditions and so many other betterments that it is futile to attempt to enumerate them, will be brought about by legislation. The inference drawn from speeches made by these political, voice-operating railroad geniuses is that railroads are actually suffering from lack of laws which govern their operation and yet, the able and discerning writer, Scrutator, in the August 21 issue of the Chicago Tribune, says in part:

"To speak of private management of railroads under present conditions, however, is almost to invite confusion of thought. Government tells the railroads *how much* they can charge for what they have to sell, *when* they can borrow money, *how much* they can borrow and *how much* they may pay for it, *how much* they must pay their employees, *how long* and *under what* conditions they may work them, *how* they must equip their lines, *when* and *how much* they may extend their lines, and *whether* they can cut off dead and

unprofitable branches, *how* they must keep their books, and so on.

"In some respects railroad history in recent years suggests a duel. Engineering and science on the one hand have been fighting regimentation on the other, and as fast as onerous conditions have been imposed, efforts have been made to reduce such burdens by employing new equipment and methods. *How long* this contest of science and law can be kept up remains to be seen."

Some years ago a gentleman from Wisconsin convinced *himself*, the *public*, and *Congress*, that a large proportion of railroad capitalization was water and he effected legislation whereby an estimated $100,000,000 was appropriated by the government, for railroad valuation and, in June of the current year, an appropriation of $350,000 was asked to get further figures. And yet, when compilation of valuation figures indicated values greater than capitalization, it was expected that the gentleman from Wisconsin would feel rather ashamed to think he had been instrumental in spending our government's money to prove he did not know what he was talking about, but to the contrary, he claimed to have been used very shabbily, as valuation experts had placed current values on railroad holdings, whereas they should have used valuations as of 1913 and, had these figures been used, his original contention would have been proven.

Henry Ford about four years ago bought a railroad and immediately he indicated to the press that railroad operation was to be put on a most efficient operating basis; old established rules of operation were to be disregarded and an entire new system evolved that would make railroading as great a financial success as automobile manufacturing. If you recall, he kept the press busy with his plans and prophecies and yet, after four years of endeavor, a clipping from the Chicago Tribune of March 21, 1924, says, "A report by the committee on public relations of the Eastern Railroads declares Henry Ford's railroad, the Detroit, Toledo & Ironton, has lost its owner $98,207 in the four years of operation and that there had been a great deal of misinformation printed about the railroad, and many false conclusions, editorial and otherwise had been drawn. The loss incurred despite the fact that between 1920 and 1923 the movement of automobiles increased from 14,000 tons to 1,271,000 tons. If figures quoted as to tonnage are correct, can you conceive how so able an executive as Henry Ford failed to make his dreams come true after his rash promises to make his road an unqualified financial success? He failed to make good along practical lines as all demogogic legislators will also fail if they deal in facts and not in visions and phantasies.

The railroads of the United States are without question the most vitally essential of all commercial industries and have been the greatest factor in the progress and growth of our nation and, their reward today is abuse from unscrupulous politicians whose charges of mismanagement and double dealings have been voiced so often that the public at large, and a great number of the railroad employees, have been led to believe these charges true and have aided in obtaining restrictive legislation which is slowly but surely throttling the nation's greatest asset.

If some of this destructive legislation is repealed and railroad executives are permitted to operate their roads unhampered by so many tremendously expensive regulations, they might in time produce earnings which would again attract investors and be better able to hold their own through rate reduction against its fast growing competitors, the motor truck, motor bus and ordinary automobiles.

As an example of truck competition, an article printed in the Detroit News, Sunday, August 24 (quoting H. R. Trumbower, economist in the Bureau of Public Roads) prints a survey of conditions governing milk transportation to eight large cities, Detroit, Cincinnati, Milwaukee, St. Paul, Minneapolis, Indianapolis, Baltimore and Philadelphia. In all of these cities, with the exception of the last two named, trucks transport 90 per cent of the milk supply. Comparative statistics were given for the city of Detroit for July, 1915, and February, 1924, indicating hauls by steam roads, electric roads and motor trucks.

	July, 1915		February, 1924	
		Per cent		Per cent
Steam Roads	5,368,415 lb.	41.8	775,710 lb.	2.1
Electric Roads.....	5,421,810 lb.	42.8	3,265,290 lb.	9.1
Motor Trucks	2,038,130 lb.	15.9	31,743,690 lb.	88.8

Another table was shown giving the number of trucks engaged in this service and the mileage and zones in which they operated. This table is of interest because of its denoting length of hauls and figures are as follows:

Mileage Zone	No. of Trucks	Per cent of Total
0-9	0	0
10-19	12	9.9
20-29	32	26.2
30-39	26	21.3
40-49	22	18.0
50-59	15	12.3
60-69	10	8.2
70-89	5	4.1
		100.0

Where trucks take over business formerly handled by railroads the railroad rate is adopted as the trucking charge.

From facts and figures as given, it should be apparent that truck competition is making enormous inroads on transportation formerly handled by railroads.

Railroads are accused of inefficiency and extravagance. In reply to the first charge, members of this organization are partially responsible if the charge be true, but your mere presence today and for the days to follow is a refutation of that charge as the sole purpose of our convention is the interchange of ideas, which make for greater efficiency.

The general public, however, has no idea of the handicaps which are imposed upon supervisors and over which they have little or no control. Labor organizations, particularly those of the several crafts, have not only worked a hardship upon the railroads who employ them but upon themselves, and sooner, or later will voluntarily make such changes in their various agreements as will permit certain work to be done by other than full paid mechanics. The saving thus effected can be pro-rated among the skilled mechanics performing such work as calls for skill and ability peculiar to the various trades.

A national survey of industries was made a few years ago to obtain reliable figures as to comparative wages paid railroad employees engaged in similar work and it was found that the average rate in industries other than railroads was less than that paid to railroad employees. However, it also developed that in many industries the skilled mechanic doing work requiring real skill received a much higher rate than the skilled mechanic on the railroad, but a balance was struck indicating a higher rate paid the railroad mechanic because any and all work of a mechanical nature was claimed by railroad mechanics and was paid for on a flat rate basis, whereas much of the same kind of work requiring little or no mechanical skill, was done by lower paid labor in other industries, which brought the average rate below that paid by the railroads. Because of these conditions many of the skilled railroad mechanics have permanently left the service of the railroads in order to obtain the higher compensation paid for real skill and ability in other industries.

These conditions also make for unrest among the crafts, because they know of higher wages paid and feel that they are unjustly dealt with. Other conditions being equal and if it is conceded that railroad transportation is of most vital importance to our nation's welfare and progress compensation to its employees should equal or exceed wages paid in other industries. An organization could then be effected

which is impossible under present conditions, as labor turnover, now an element most hurtful to organization, will be minimized.

As to extravagance. If the various exponents of this charge will become supervisors on one of the many railroads and function according to rules and recommendations of the material economy committee, he will surely hate and regret the fact that his vocabulary ever included the word, "extravagance," and in a short time he would hate the word "economy" with a more bitter hate than "extravagance."

Much good has been, and is being accomplished, by these committees. Many of their recommendations are seemingly of minor importance because of the small items considered but when the immensity of our railroad systems is also considered, these little savings, where made, run into enormous sums of money.

One of a supervisor's chief worries is to so handle his department that the minimum of waste and the maximum of economy is effected, thus avoiding the criticism of general officers who seemingly all are specialists on these subjects and it is surprising to note how small an article of usable material they can find in the scrap pile, and how quickly they can notice an inefficient operation.

The employees of our railroads numbered 1,879,770 in 1923 according to a report of the Interstate Commerce Commission, and if the true critical situation of the railroads could be brought to their attention in a way in which all of them could comprehend, there is no question but that much of the unrest and dissatisfaction which now prevails among them would be dissipated, and they would become a mighty factor in forcing the repeal of restrictive legislation, and the enactment of constructive or helpful legislation. President Markham of the Illinois Central is doing a great work along this line by publishing in various newspapers from time to time facts and figures, worded and compiled in such a manner, as should be readily understood by all who can read, and he invariably ends his articles by inviting constructive criticism and suggestions.

If more railroad officers and executives were to follow his example, if the government through the Interstate Commerce Commission were to challenge and deny charges made that their figures are in error, and if the country could be covered by as many forceful speakers, possessed of authentic and incontrovertible facts and figures exposing the misrepresentation which puts the railroads in a false position before the public, a wonderful change in conditions would soon be brought about. As a whole, we are a nation composed of fair minded people, but unfortunately at times it takes some terrible calamity to awaken us to an impossible condition we have allowed to obtain through indifference, and lack of interest. It is to be hoped that the public will awaken to an understanding of the railroad situation before it is too late. The members of this organization should possess themselves of all available data which can be authenticated beyond doubt and, by refutation of erroneous and hurtful charges, try and bring about a better understanding of real conditions as they truly exist on the part of our fellow employees.

Every railroad employee knows of the retrenchments that have been made in order that a reasonable financial showing could be made. He knows this because of lay-offs, shutdowns, explanations to him as to why certain tools or equipment has not been furnished, by the number of locomotives that are tied up through the fewer number of trains run, etc., and it would seem that it should not be hard to bring him to a true understanding of conditions.

I trust that our members will not understand this message as having political significance beyond my sincere interest in the railroad's welfare as I have no desire nor right, under our constitution to indicate political preferences in our proceedings. I have only touched briefly on a few of many pertinent facts of the present which will become aggravated if the near future does not bring relief.

Instead of condemnation surely much credit is due stock holders and executives for maintaining a struggle against odds which seem hopeless and may they soon by reason of right, prevail over prejudice and be permitted to operate their roads with as fair a financial return as any other essential industry. Our part in the struggle must be to exercise our mechanical and executive ability to the utmost and make for the ultimate in efficiency.

Better Terminals versus More Locomotives

By L. G. Plant

Assistant to the President, National Boiler Washing Company, Chicago

THE design, operation and maintenance of motive power should be governed so far as possible by four fundamental objectives: first, dependable design and reliable operation; second, efficiency in operating cost and capacity; third, maximum output of the most efficient motive power units; fourth, economy in the maintenance of locomotives in a dependable, efficient and productive condition.

Dependable power has always been regarded as the most vital requirement upon the motive power department. The consequences of a failure on the road are such that in locomotive construction and subsequent maintenance, operating reliability is the first consideration. No feature in design however efficient, nor maintenance practice however economical will ever be tolerated on American railroads if it impairs the ability of the locomotive to "get over the road." Those who have sought to improve motive power efficiency by the application of auxiliary devices have found that they must first provide equipment that can be depended upon to function reliably.

No saving in the cost of operating locomotive shops and terminals will justify engine failures resulting from too rigid economy in their maintenance. Nor can the time that locomotives are available for service be increased at the expense of time actually required for maintaining these locomotives in a dependable operating condition. Any permanent improvement in locomotive output must be based upon sound operating methods and better facilities for maintaining motive power in a servicable condition.

Next to reliability in locomotive operation comes efficiency. Locomotive efficiency implies more than a relation between output and the fuel consumed; it includes capacity, both in respect to the investment involved and the size and weight of the locomotive itself. Efficiency in locomotive design and condition is the next most important requirement upon the motive power department.

Operate Most Economical Units

Maximum efficiency in locomotive performance cannot be realized without obtaining the maximum output from individual locomotives. Locomotive operation should always be concentrated upon the most efficient units and the maximum output continually secured from these locomotives so that the less efficient units can be stored. This practice is an important cause contributing to the substantial reduction in unit operating costs that have been registered by a number of railroads in recent years.

Compare, for example, the situation on the Union Pacific in March, 1924, with January, 1920. The gross freight tonmileage, excluding weight of locomotive and tender, was 1,629,127 in March, 1924, and 1,624,860 in January, 1920. slightly higher in March, 1924, but the volume of freight traffic or amount of work performed by motive power in this class of service is sufficiently similar to afford a good basis

for comparison. In January, 1920, the Union Pacific had an average of 371 serviceable freight locomotives, of which only 5 were stored. In March, 1924, this road reported an average of 459 serviceable freight locomotives on line but 184 of these locomotives were stored. In other words, the Union Pacific produced practically the same ton-mileage in March, 1924, with an average of 275 locomotives in freight service that it produced in January four years ago with 365 locomotives in this service.

It is evident that the Union Pacific could not have effected this large increase in the output of each individual freight power unit without the acquisition of more powerful and efficient freight locomotives. But it is also significant that along with the addition of these new locomotives, the railroad has pursued a systematic policy of storing the less efficient locomotives so that the average productive time of each locomotive in freight service is practically as high as it was when the number of locomotives available for service was considerably less. The Union Pacific could not have achieved its present state of operating efficiency with all its new motive power in use had it also retained the less efficient locomotives in service and allowed the average output of all freight locomotives to decline.

Too Many Locomotives—Too Few Terminal Facilities

There is a fixed "overhead" expense attached to every locomotive that continues whether the locomotive is in operation or idle. This "overhead" expense increases or drops with a decrease or rise in the traffic volume and can only be controlled through a policy governing the purchase of locomotives. Where increases in freight traffic have been met by increasing the average output of the locomotives in this service instead of placing proportionally large orders for additional motive power to handle the business, this policy has reduced the "overhead" expense for each locomotive owned. Conversely, there is no greater incentive toward increasing the individual output of locomotives owned than an actual shortage of power and some of the best examples of what can actually be accomplished in the utilization of motive power are afforded by these railroads on which motive power purchases have been restricted as a matter of policy or financial necessity.

The president of a locomotive company was recently quoted as having stated that there were too many locomotives in this country. This has no serious bearing upon the business of the locomotive manufacturers which is primarily that of replacing worn out and inefficient units with modern motive power that will save more than enough in operating costs to absorb depreciation and pay interest on the investment. But this statement is literally substantiated by a study of the actual situation that clearly indicates a greater need generally for expenditures upon locomotive terminals and other facilities for increasing the earning power of existing locomotives than for the purchase of additional motive power.

The greatest obstacle to this policy lies in the relative difficulty of obtaining funds for improvements to mortgaged property in comparison with the ease with which money can be secured for the purchase of locomotives through the sale of equipment trust obligations. A solution to this difficulty is found in the rental of improved terminal facilities from contractors who are able to install and finance these improvements on this basis.

The problem of increasing the individual output of locomotives has acquired added importance with recent increases in the cost of motive power. The modern locomotive can, in reality, be regarded as a seventy-five or one hundred thousand dollar power plant. What would we be obliged to pay for electric current in any city, if supplied by three separate power plants each operating an average of less than eight hours out of twenty-four? To make this parallel complete, let us assume that the fires under the stationary boilers are dumped after each run.

This is substantially the condition applying to the average locomotive, which can be considered a self-contained power plant on wheels. It is possible that if these three power plants were each "assigned" to an individual crew, that these men would take a greater personal interest in their "assigned" power plant, would cultivate more flower beds surrounding the building, keep the brass railings polished somewhat brighter and perhaps reduce the maintenance cost to some extent. But it is apparent that both the operating and investment expense of such an arrangement would increase the cost of electric current to a figure that would not be tolerated in any community.

The same economic laws that govern the cost of electric current generated in a stationary power plant also control the cost of tractive force at the draw-bar of the locomotive. But the conditions under which locomotives are operated make it impossible for them to maintain continuous service, at least without radical changes in design and vastly improved terminal facilities. The rack and wear of running over uneven roadbeds and the intense rates of evaporation in locomotive boilers necessitate withdrawal from service for periodic shoppings.

But with all the limitations under which locomotives are required to operate, an opportunity exists on nearly every railroad for deriving a higher return upon its investment in motive power by reducing the non-productive time of locomotives. This is the time that locomotives are not actually in operation on the road and is called non-productive because a road locomotive cannot earn any revenue for the railroad when it is standing at a terminal or in a shop. A portion of the time now spent in terminals and shops is unavoidable but a comparison of locomotive performance on various railroads shows such discrepancies in the average non-productive time of locomotives as to suggest that with the necessary facilities a considerable improvement in the utilization of locomotives could be effected by a number of railroads.

The American Railway Association now has a committee including both operating and mechanical department officials who have been appointed to deal with the problem of locomotive utilization. A sub-committee is already at work on a study of the situation on various railroads with respect to this problem. An analysis of the methods and facilities on these roads will point the way to a substantial reduction in the non-productive time of locomotives but the subject should always be viewed broadly. The analysis might otherwise become so detailed as to obscure the real issue.

Locomotive Output Both an Operating and Mechanical Problem

The question of which department is responsible for a terminal delay is not of such consequence as the magnitude of the delay itself. Attempts to register the proportion of terminal detention for which the operating and mechanical departments are separately responsible usually degenerate into a futile effort to see which department is most successful at "passing the buck." The important thing is to keep the most efficient power in operation as much of the time as possible and this is an objective in which both departments are jointly concerned.

There are a number of admirable methods for improving locomotive utilization which the work of the American Railway Association's Committee will emphasize. The most widely advertised practice is the recent extension of locomotive runs. The inauguration of "Main-Trackers" or the continuous operation of freight trains through congested terminals without changing locomotives has undoubtedly contributed to the relatively high percentage of time the freight locomotives are in service on the Baltimore & Ohio.

Another railroad arbitrarily requires its division officials to store a certain number of serviceable locomotives as soon as the average locomotive mileage for the division falls below a standard value.

Locomotive terminal and shop facilities, however, are the determining factors in respect to locomotive utilization and any comprehensive analysis of this problem must take these facilities into account. The effect of maintenance facilities upon the earning power of locomotives is more evident in the design of terminals than in the equipment of large shops. Locomotive terminal facilities not only govern the length of time that locomotives must be held out of service between each run but, with adequate equipment for current running repair work at the terminal, the length of time between heavy repairs for which the locomotive must be sent to the general shop can be materially lengthened.

Efficiency and Output More Important Than Repair Costs

It has been contended that the cost of making repairs at a number of terminals is generally higher than if this same work were concentrated at a large shop. But if the time that locomotives are available for service can thus be increased, the value of their additional earning ability should be weighed against the higher repair costs involved in making repairs at terminals. Reliability and efficiency in operation are also factors which take precedence over the cost of repairs provided this is not excessive. It is reported that one railroad on which the locomotive performance is particularly good both from the standpoint of operating efficiency and the utilization of motive power, is systematically making running repairs to locomotives each month coincident with monthly boiler inspection and washout.

The necessity for better locomotive utilization will compel improved locomotive terminal facilities that are designed for turning locomotives more rapidly and equipped for reducing the time required for current maintenance and repairs to locomotives. The locomotive terminal should no longer be regarded as a mere shelter for locomotives at the end of the run, means for turning these locomotives and for supplying them with fuel, sand and water. By increasing the output of the most efficient locomotives, the terminal can contribute indirectly, but none the less effectively to locomotive efficiency. There is also a direct economy resulting from improved terminal facilities and some types of terminal equipment can be classed as direct fuel savers, comparable in their effect to any of the numerous economy devices now being applied to locomotives. But in contrast with locomotive appliances, terminal equipment tends to reduce rather than increase locomotive maintenance costs.

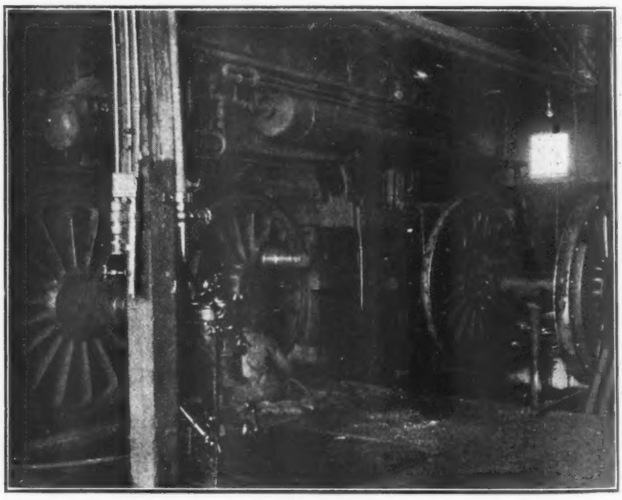
No single terminal device has a more direct effect upon locomotive utilization or has greater possibilities for improving the efficiency and capacity of locomotive operation than equipment for washing and refilling locomotive boilers with hot water together with a recent development of this system which provides for steaming up locomotives by the direct injection of steam and hot water. This will enable large locomotives to be filled and steamed up in approximately half an hour and also makes it possible to generate a working steam pressure before the fire is lighted.

Economy in the maintenance of locomotives has been referred to as the fourth objective although it is generally regarded as the first and most definite requirement upon the motive power department. In fact, the mechanical organization is often controlled entirely from a cost standpoint. This would not be so objectionable if a more logical unit than locomotive miles were applied to maintenance costs.

Ten years ago, it is recalled that only one railroad in the southeast and but few roads in other parts of the country computed fuel consumption upon a gross ton-mile basis in freight service. Fuel was then recorded upon a train-mile basis without regard to whether the figures applied to a 3,000-ton main line freight or a branch line local. All railroads now report fuel used in freight service upon a gross ton-mile basis and passenger fuel consumption upon a car-mile basis. But the statisticians still persist in basing maintenance costs upon the locomotive mile without regard to whether the costs apply to an eight-wheel "Tea-Kettle" on a regular branch line run or to a modern Mikado in a main-line pool. Unlike other necessary improvements, intelligent accounting does not require a large expenditure. True economy in locomotive maintenance cannot be achieved until the expenditures for this purpose are judged by a proper standard.

Labor Saving Devices

A drop pit jack with a hydraulic pump is illustrated. The pump was made from an old worn out 9½ in. air pump by substituting a piece of steel tubing, and two check valves for the air cylinder. This pump is located on a post and the discharge line is connected to each stall of the drop pit by suitable fittings. The water intake is connected to the enginehouse washout line. The pump is operated at the post. This, you can readily see, eliminates the hazardous condition of operating the drop pit jack down under the wheels. It also eliminates the laborious work of pumping the drop pit jack with a lever. Two men can easily do the work of four men and a great saving of time will be made, both in applying wheels, or removing wheels



Drop Pit Jack Operated by Hydraulic Pump

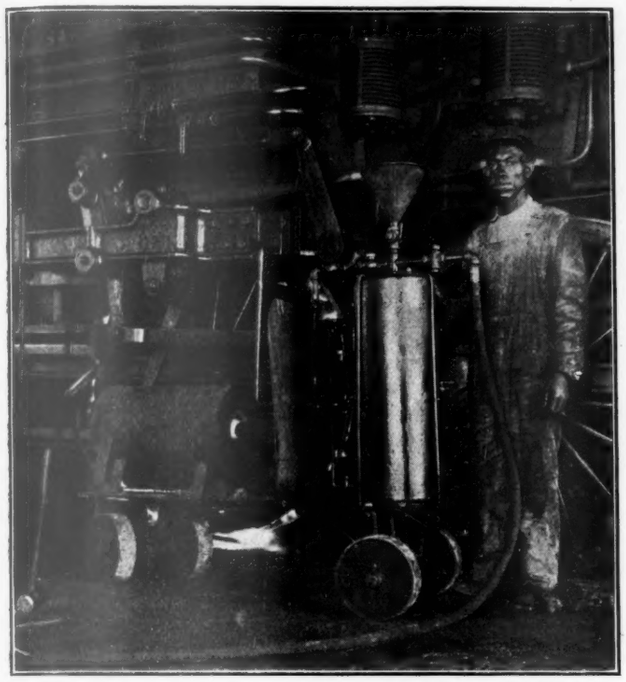
from an engine. We have a record time of wheeling a six wheel switch engine in 17 minutes. This time includes removing the covering from the drop pit before wheeling and covering it after the engine is wheeled. This arrangement does not necessitate the removal of the lever attachment of the drop pit jack, so that it can be operated in the ordinary way if so desired.

Portable Tire Heater

A portable tire heater was made with two pair of truck wheels, an auxiliary reservoir, some sheet iron, pipe fittings and valves.

It is very easily constructed, the principal feature being a pre-heating or atomizing chamber. The fuel oil is thoroughly vaporized to a gas in this chamber and it then passes to the hoop burner around the tire in a highly combustible form which results in an intense white heat being forced against the tire. As you will notice by referring to the photograph, which was taken while in operation, there

is no smoke or unburnt gases escaping from the burner. The burner is easily operated, does not require a skilful operator and will heat a tire 68 in. in diameter, 3½ in.

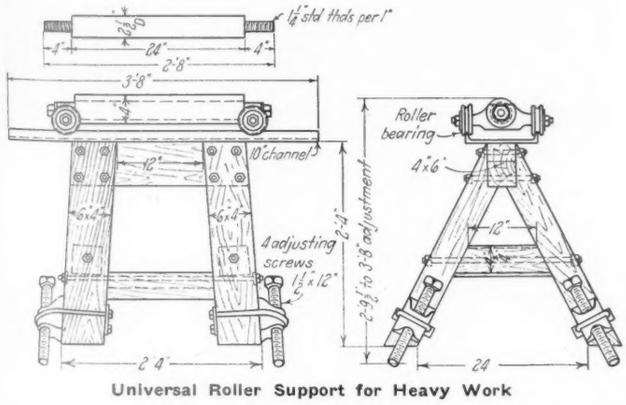


Portable Tire Heater Which Has Given Effective Service

thick in 10 to 12 minutes. Also it is absolutely safe to operate, there being no danger of explosion.

Universal Roller Support for Heavy Work

A universal roller support for supporting heavy work such as locomotive frames, etc., while being machined on a slotter is shown in the drawing. This device consists of a wooden horse, equipped with adjusting screws on the legs for adjusting for proper height, a channel iron that

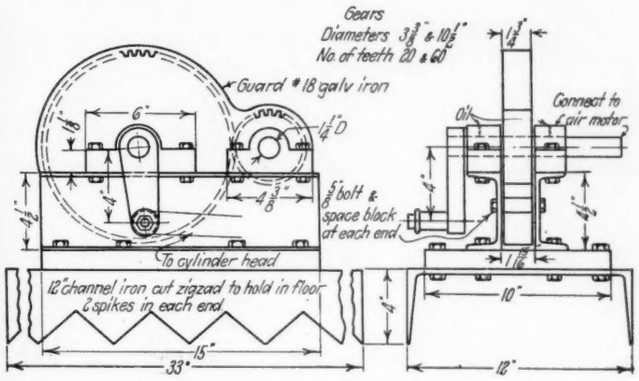


Universal Roller Support for Heavy Work

is used as a track for the wheels to roll in, and a piece of steel tubing that acts as a roller. By referring to the sketch, it can be seen that the support works in two directions which gives the slotter operator free use of his table for any motion that may be necessary in performing his work, consequently saving a great deal of time for machining any heavy work.

Machine for Grinding Cylinder Head Joints

Another drawing shows a machine for grinding cylinder head joints. This device is very simple and costs very little to construct. It consists principally of two gears, ratio 3 to 1, a crank and a connecting rod and is operated with an ordinary air motor. The cylinder head is held in place with a rod through the center with the tension of a brake cylinder release spring. An air motor operates the gear train and by means of a connecting rod. The crank arm gives a reciprocating rotary motion to the cylinder head. This

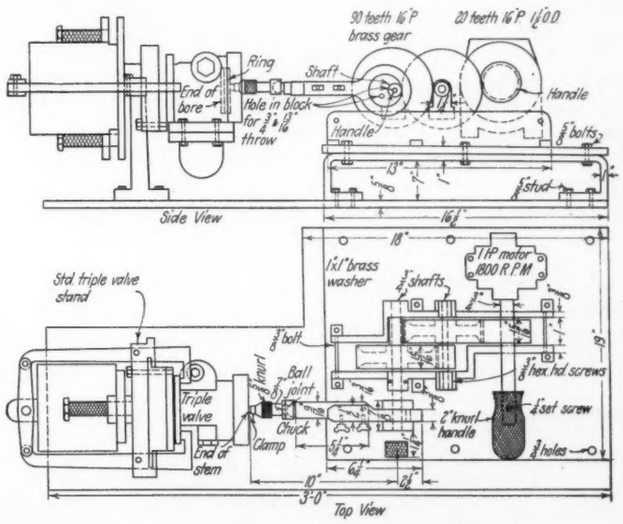


Machine for Grinding Cylinder Head Joints

machine is a great time saver for the reason that after it is set up, it requires little or no attention of the machinist until the joint is ground. Therefore, he can carry on his other work while the machine is in operation. I have seen a 9½ in. air pump used to operate a cylinder head grinder but this gear arrangement, using an air motor, is more economical because it does not use as much air to operate and is much faster.

Device for Lapping in Piston Rings and Slide Valves in Triple Valves

A device for lapping in piston rings and slide valves in triple valves is also illustrated. It is simple of construction as can be seen from the sketch and results in a great saving of time from the fact that, after it has started lapping,

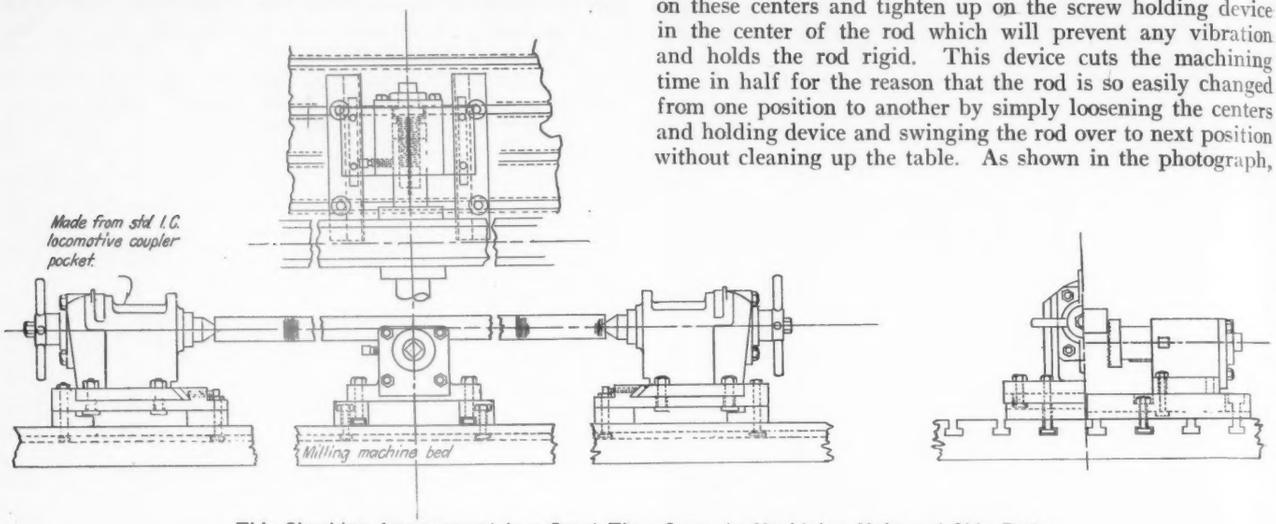


Device for Lapping in Triple Valve Piston Rings

it requires no attention from the operator, who can be preparing the next triple for the lapping operation. Also, this machine does a much better job than is possible to do by hand.

The development of labor saving devices should have the same consideration as is given by the organization to the output of the shop. The supervision has learned that it pays to

organize a department where labor saving devices as suggested can be experimented with and made up ready for use, such as, air clamps and vises on drill presses, jigs and fixtures for holding various castings and forgings while performing, drilling, shaping or planing operations, where gages



This Chucking Arrangement Is a Great Time Saver in Machining Main and Side Rods

can be made and used for standard articles that are manufactured instead of calipers, gang tools and special taps and cutters, forming tools, special hammer dies, and a similar class of tools.

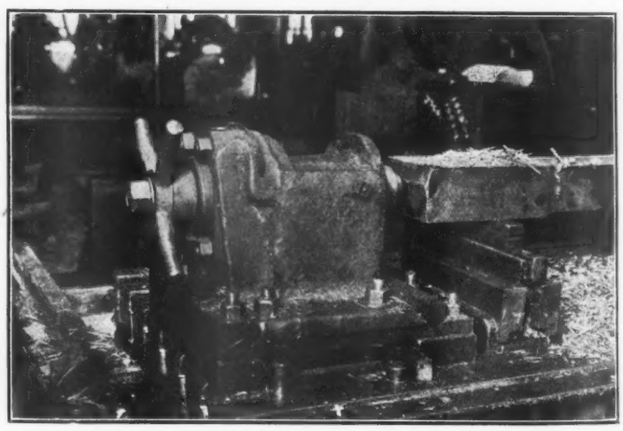
The money expended on a labor saving device should be governed by the number of articles or the amount of work to be done. In large shops it pays to expend a large amount of money on a labor saving device on account of the large amount of work, whereas in a small shop it would not pay to expend as large an amount of money.

It may happen that a suggestion is tried out and found to be impracticable and those making the suggestion become discouraged but is it not better to encourage the initiative of the organization with respect to the development of labor saving devices in shop organization so the work can be facilitated than to continue systems in the shop that close the door to progress. There is no end to the advancement and the savings which can be made by the organization who are always putting forth new ideas in connection with their work.

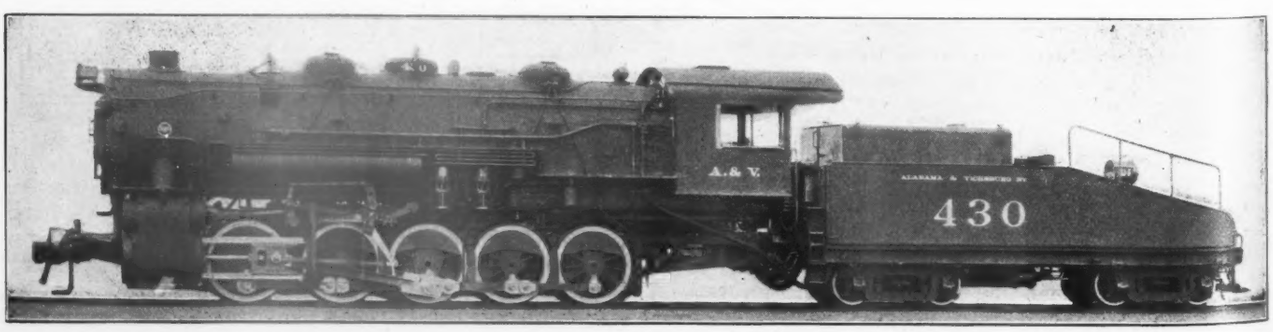
This report was read by F. W. Lauer, Illinois Central, chairman.

Chucking Apparatus for Holding Main Rods on Slab Milling Machine

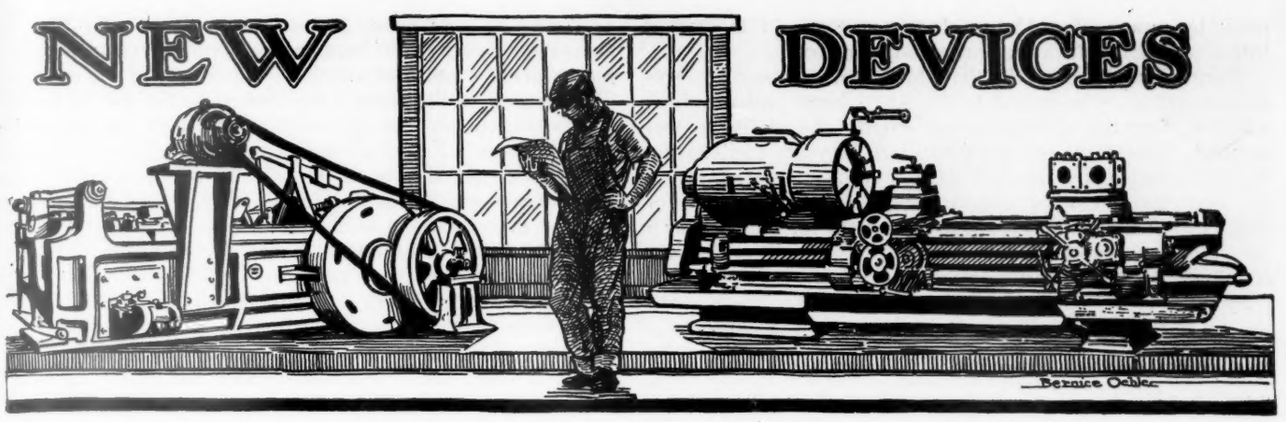
A chucking or holding apparatus for holding main side rods on a slab milling machine, while being machined is shown in two of the illustrations. This device consists of two head stocks and a screw clamp. The head stocks are very similar to a lathe tail stock and were made from two scrap coupler pocket castings. The forged rods are drilled and reamed for 75 degree lathe center. Then all that is necessary to set these rods up for machining, is to put them on these centers and tighten up on the screw holding device in the center of the rod which will prevent any vibration and holds the rod rigid. This device cuts the machining time in half for the reason that the rod is so easily changed from one position to another by simply loosening the centers and holding device and swinging the rod over to next position without cleaning up the table. As shown in the photograph, the ends of the rod may be supported by blocking up from the table, which relieves the centers from the cutting strain. These supports, however, do not interfere with the rapid realinement of the forging when changing from one face to another. The drawing shown gives a clear understanding as to how the device is fastened on the bed of the milling machine.



Close-Up View of One End of Chuck for Holding Rods



Ten-Wheel Switcher, Tractive Effort 78,200 lb., Built for the Alabama & Vicksburg by the Baldwin Locomotive Works



Electric Cinder Handling Equipment

THE economy of modern cinder handling equipment as compared with earlier methods of disposal is shown in a striking manner by a study of a Roberts & Schaefer N. & W. electric type installation which has just been made by the A. C. Nielsen Company, an independent engineering organization of Chicago, in co-operation with the railway on whose line the plant is located. This

This Plant Handles the Ashes from 24 Locomotives Each Day

railroad does a freight business exclusively, and serves as a connecting road for several other lines. Years ago the ashes from the locomotives were removed in wheelbarrows, this expensive process being later replaced by a locomotive crane, which took the ashes from a pit beneath the track. While the crane effected a considerable saving, it was felt that the cost could be still further reduced. Satisfactory experience with two Roberts & Schaefer coal handling plants led to an investigation of the N. & W. type electric cinder plant made by the same company. This investigation indicated a large possible saving over the crane method.

The cinder plant was installed in the summer of 1923. It handles the ashes from 24 locomotives regularly, and does considerable work for other engines as well. As the fire is cleaned, the ashes are dumped into a hopper beneath the track, and from there they drop into a skip car having a capacity of 80 cu. ft. This car is hoisted on an inclined

SUMMARY OF COSTS AND SAVINGS

Cost of operating electric cinder plant:	
Depreciation—$8,828.56 (20 years' life)	$441.43
*Average interest at 6 per cent $\frac{21}{20} \times \frac{\$8{,}828.56 \times .06}{2}$	278.10
Allowance for repairs and maintenance	100.00
Fixed cost per year	$819.53
Fixed cost for 8 months—$819.53 $\times \frac{8}{12}$	$546.35
Power	158.12
Direct labor	1,042.80
Supervision	260.76
Total cost for 8 months	$2,008.03
Tons handled	3,570
Cost per ton $\frac{\$2{,}008.03}{3{,}570}$	$.562
Operating cost at full capacity:	
Fixed cost per year, present basis	$819.43
Additional repair allowance	200.00
Fixed cost per year, at maximum capacity	$1,019.43
Fixed cost per day, $1,019.43 (300 days)	$3.40
Power, 100 tons at $.0443 per ton (present cost)	4.43
Labor, 24 hours, at $.44	10.56
Supervision	1.30
Cost per day	$19.69
Cost per ton $\frac{\$19.69}{100}$	$.197
Savings of electric cinder plant over locomotive crane:	
Cost per ton, locomotive crane	$1.160
Cost per ton, cinder plant	.562
Net saving per ton	$.598
Net saving for 8 months, $5.98 x 3,570 tons	2,134.86
Corresponding net saving per year, $2,134.86 $\times \frac{12}{8}$	3,202.29
Net annual return on investment	36%
The electric cinder plant pays for itself in less than 3 years.	
Savings of electric cinder plant over hand method:	
Cost per ton, hand method	$2.000
Cost per ton, cinder plant	.562
Net saving per ton	$1.438
Net saving for 8 months, $1.438 x 3,570 tons	$5,133.66
Corresponding net saving per year, $5,133.66 $\times \frac{12}{8}$	7,700.49
The cinder plant pays for itself in less than 14 months.	

*Allowing for interest earned by depreciation reserve.

track by means of a 15-hp. electric motor, and discharges into a standard railway car on an adjacent track.

During the eight months that this plant has been in service, repairs have amounted to $58.95, a large part of which was for electrical alterations not strictly chargeable to this account. The plant is expected to last 20 years and charges for depreciation are on that basis. Adding interest at six per cent, and including an allowance of $100 per year for repairs and maintenance, which allows for an increase with age, the total annual fixed cost is $819.53. Prorated for eight months, this amounts to $546.35.

Power for the same period cost $158.12, or about $0.0443 per ton of ashes handled. Supervision cost $260.76 and labor amounted to $1,042.80, which is about equal to 10 hours a day for one man. The plant is in use during three shifts daily, but it does not occupy the full time of a man. The total cost for the period of eight months was $2,008.03, which for the 3,570 tons handled, amounts to $0.562 a ton of cinders. This cost will be decreased when the plant is given more work. To date, it has handled only about 18 tons of cinders a day, and since it can handle 100 tons, it has been operating at only about 18 per cent of full capacity. On some days, however, 50 locomotives have been cleaned, which means about 63 tons of ashes or 63 per cent of the capacity. The capacity of the plant it not limited by the size and speed of the skip, but by the time required to clean the locomotive fires, between 12 and 15 minutes being required for each locomotive. As shown on the accompanying cost sheet, the cost when operating at full capacity will be $0.197 a ton.

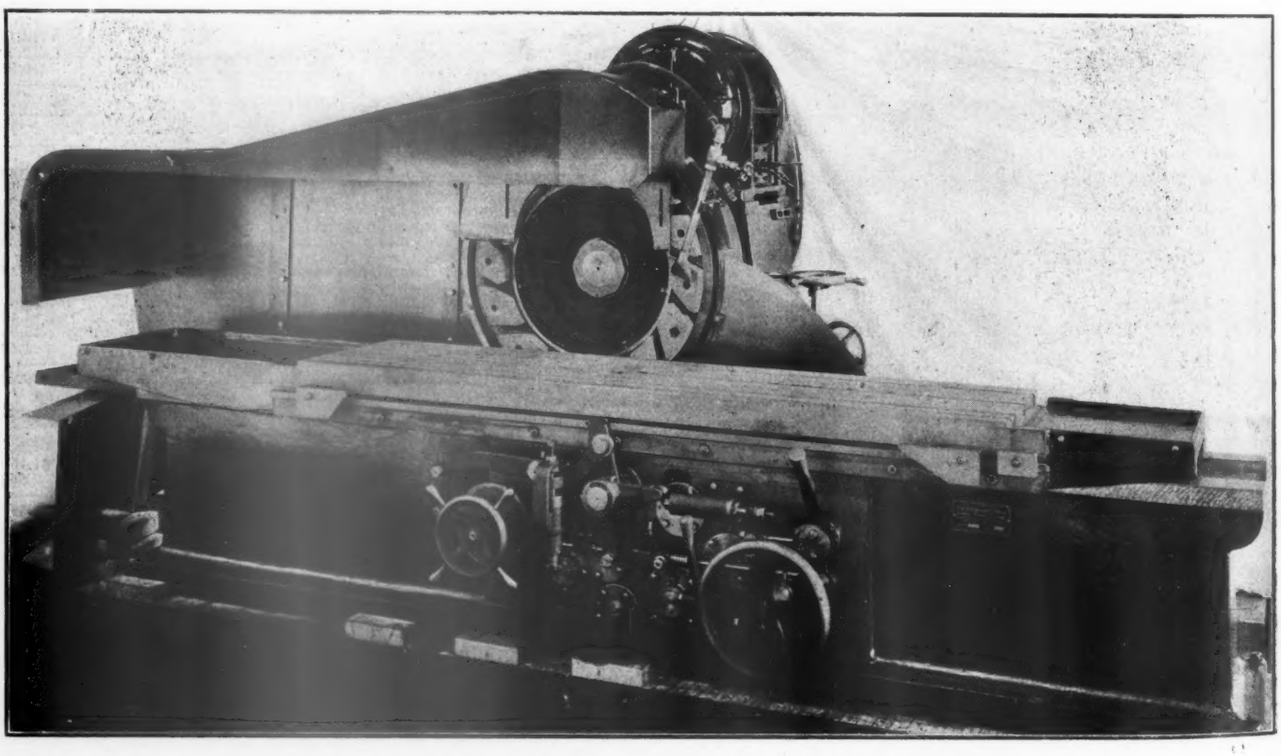
The cinder plant has effected an appreciable saving compared with the locomotive crane. When the crane was abandoned the cost was averaging $1.16 a ton. Since the new plant does the work at a cost of only $0.562 a ton, the net saving is $0.598 a ton, which amounted to $2,134.86 for the eight months' period. This is equivalent to $3,202.29 a year, which is a net annual return of 36 per cent on the investment. In other words, the cinder plant will repay its cost in less than three years and as the amount of work increases, the savings will be even larger.

The hand method cost about $2 a ton in comparison with which the cost is reduced to $1.438 a ton, or $7,700.49 annually. This will pay for the plant in less than 14 months.

Bridgeport Heavy Duty Face Grinder

IN the recent development of heavy duty face grinders the Bridgeport Safety Emery Wheel Company, Bridgeport, Conn., has brought out a new and improved machine which is particularly adapted to railroad shop work such as the grinding of locomotive guides. This machine, known as the type 84 T. S., is of extremely durable construction throughout, and is designed to take the heaviest cuts without undue vibration. The drives throughout are positive as all belting has been eliminated. The general arrangement of the grinder is such that complete control and ease of operation is assured, and its compact design permits the use of a minimum of floor space.

The use of the 14-section 32-in. grinding wheel provides a grinder with many advantages and economies because of the fact that the abrasive sections are adjustable so as to be taken up as they wear, are easily renewed and the space between the sections forms channels for carrying away the grinding refuse so that the cutting faces do not foul. The sectional arrangement also tends to provide a means for the cooling agent to penetrate to the cutting points and carry



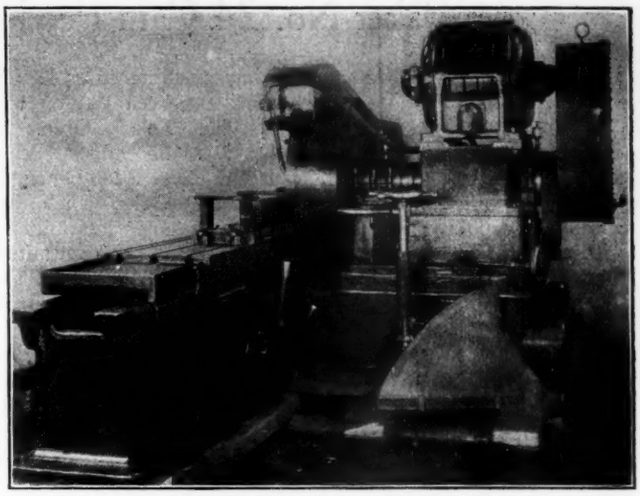
Heavy Duty Face Grinder Particularly Adapted to the Finishing of Locomotive Guides

away the generated heat more rapidly than with a solid wheel.

The spindle is heavy and is carried on ball bearings which resist all radial and thrust loads in each direction. Power is provided by means of a directly connected motor mounted above the spindle, and the water pump is driven as an individual unit by a separate motor.

It has been found that on this class of grinder it is necessary that the operator be able to control the machine from either the front or back. On this machine the operator is able to start, stop or reverse the carriage, as well as to control the speed, feed and flow of water from either position.

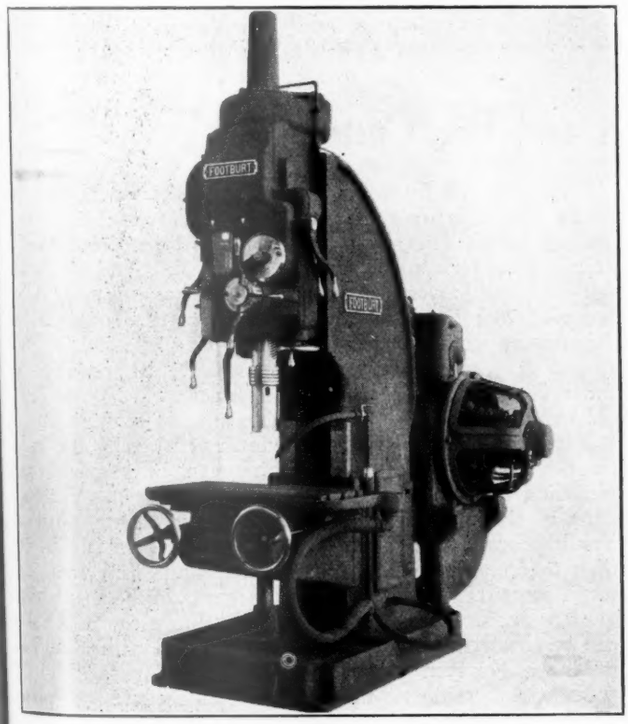
A graduated arc indicates the amount of swivel of the grinding head, which may be set for concave grinding by means of a hand wheel. An automatice feeding arrangement is provided which, together with a large range of work table speeds, makes possible the production of high quality work within limits of .0005 in. Specially designed settling tanks and a high capacity water pump assure an abundant supply of clean cool water on the work at all times. This grinder is regularly made in four table lengths from 66 in. to 140 in. with a width of 20 in. and can, if desired, be equipped with a magnetic chuck.



Bridgeport Grinder Showing Directly Connected Motor Mounted Above the Spindle

Heavy Duty Drilling Machine

A DRILLING machine which has a rated drilling capacity of 5 in. in solid steel, made possible by its rigidity of design, has been placed on the market by The Foote-Burt Company, Cleveland, Ohio. Some of the outstanding features of the machine are that the head unit can be entirely detached from the upright and that the speed changes can be easily obtained through a sliding gear arrangement.



The Head Unit, Containing All Mechanism, Can Be Detached from the Upright of This Foot-Burt Drill

The head of the machine is bolted to the face of the upright, so that the bolts are in shear instead of in tension. This assists in giving unusual strength to the head and upright construction, and tends to prevent any deflection at the point of the drill through additional rigidity secured with this arrangement.

This is a feature which is essential for production work.

Another interesting feature is that the head unit can be entirely detached from the upright, as the entire mechanism of the machine is contained in the head proper. This construction provides for a pump lubrication system, thereby eliminating the necessity of hand oiling. It also permits the removal of the complete head without disturbing the balance of the machine. This is particularly important when a number of these machines are used close together, as it is possible to remove the head holding bolts, and by hooking the crane to the top of the head, lift it from the balance of the machine without interfering in any way whatever with the machines in its vicinity.

The speed changes are obtained through a sliding gear arrangement similar to that used in the modern automobile transmission. Nine speed changes are easily obtained by manipulating the speed change levers. By transposing one set of pick-off gears, a total of eighteen feed changes can be secured. Steel gears are used throughout. With the exception of the sliding gears, which are stub-toothed, spiral gears are used, including spiral bevel gears for the main drive of the machine. With only one exception roller bearings are used throughout the machine, which reduce frictional wear to a minimum. The spindle bearing is of a high grade bronze.

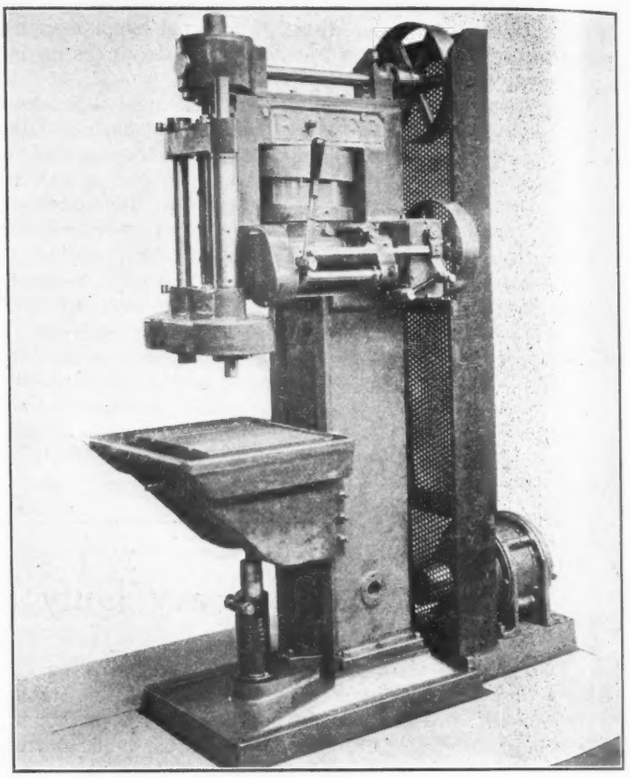
Some of the general specifications are as follows: The distance of the nose of the spindle to the top of the plain table is 35 in.; the distance of the center of the spindle to the face of the column is 18 in.; the diameter of the spindle bearing in the sleeve is 3 in.; the diameter of the spindle nose is 5 in.; the spindle is equipped with a No. 6 Morse taper; the working surface of the plain table is 24 in. by 24 in.; the table vertical adjustment is 18 in.; there are 18 feed changes from .100 in. to .140 in.; nine speed changes from 25 to 201 r. p. m.; the net weight of the machine with a plain table is approximately 10,000 lb.; with the compound table approximately 11,000 lb.

Baker No. 24 Cam Feed Drilling and Boring Machine

A CAM feed drilling and boring machine suitable for handling medium heavy work has been put on the market by the Baker Brothers, Inc., Toledo, Ohio. It is especially adapted to facing work, as the cams are designed to face to the required depth, then have a long enough dwell to completely clean up the surface, after which the spindle is quickly withdrawn. In like manner intermittent drilling can be done, the cam giving a rapid advance automatically between the holes that are to be bored or drilled. The operator has both hands free at all times for the removal and the chucking of work.

The machine is simple and is ruggedly constructed. The gears and ball bearings are made of alloy steel. It is also built with a circular full automatic indexing table. It can be furnished with a single or a double spindle. The one illustrated is a two-spindle machine for boring connecting rods. The one-spindle machine is adjustable vertically to take care of tool grinding.

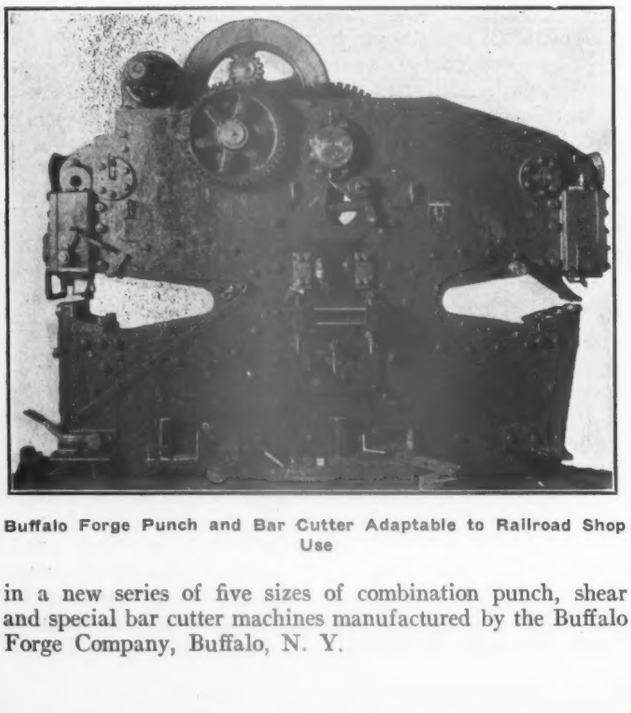
The following specifications give an idea of the size and capacity of the machine. The capacity of a single spindle using a high speed drill working in solid steel is 1½ in. per minute. The capacity is proportionate in boring or multiple operations. The spindle has a No. 4 Morse taper. The distance of the center of the spindle to the face of the lower frame is 10 in. The floor space required when driven by a belt is 28 in. by 36 in., and when arranged for motor drive 27 in. by 57 in. The maximum distance of the end of the spindle in its highest position to the table is 22 in. The size of the finished surface plain table is 15 in. by 16 in. The weight of the belt-driven machine is 2,550 lb. The feeds and speeds are furnished special for each machine. One set of cams is included as standard equipment with each machine.



A Two Spindle Installation for Boring Connecting Rods Having One Spindle Adjustable Vertically to Take Care of Tool Grinding

Combination Punch and Bar Cutter

SOME features of importance for the shop engaged in repair work, such as a locomotive repair shop where but few of the operations are standardized, are included in a new series of five sizes of combination punch, shear and special bar cutter machines manufactured by the Buffalo Forge Company, Buffalo, N. Y.



Buffalo Forge Punch and Bar Cutter Adaptable to Railroad Shop Use

The principal feature, which makes these machines especially adaptable for repair work, is the universal bar cutter arrangement. This is so designed and constructed that it can be used for rounds, squares, angles, flats and tees without changing knives. Constituting a part of this section but separate from it, are the knives used for cutting channels and I-beams and other rolled pieces requiring openings of this shape. These latter, however, are not universal and a special knife is required for each size channel and I-beam used. Of importance when a considerable amount of punching is required in the shop, is the arrangement whereby the knife on the shear end of the machine can be removed and punching tools inserted in its place. In this manner both ends of the machine can be used for punching purposes simultaneously. The shearing arrangement here is different than that on the standard punch, bar and shear machines manufactured by this company. Placement of the shear knife at right angles to the frame necessarily limits the width that can be sheared to the depth of the throat. On the standard machines, however, the knife can be placed parallel to the frame and therefore no limit is placed on the width of plates which can be sheared.

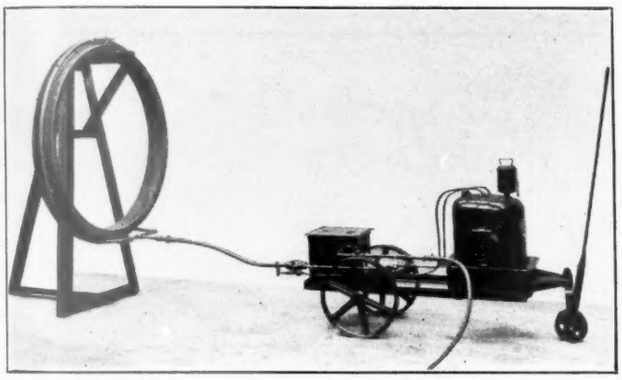
These machines are built with steel gearing throughout and with nickel-steel pinions. Because of their greater strength, the new steel gears can be made smaller, thereby saving in weight and space requirements. The machines are all equipped with a mitering arrangement for angle sections. All bearings, in addition to being bronze lined, have ample provision for oiling. The flywheel bearings are ring oiled, while the plungers are lubricated by means of oil grooves.

The method of drive may be either by pulley or by motor. The punch with these machines is provided with a gag, making it semi-floating; engagement can be made either by a handle or a foot treadle. Stops for shearing angles are adjustable to any degree desired. The frame construction is of armor plate.

The punching capacity of the new series machines ranges from 1 in. by ½ in. for the smallest size to 1¾ in. by 1½ in. for the largest size. The slitting plate capacity ranges from ½ in. to 1½ in. Other capacities such as those for squares, rounds, angles, etc., have a corresponding range of cutting.

Hauck Suction Type Tire Heater

A TIRE heater made in two halves which can be placed on the tire without dismantling the driving gear of the locomotive has recently been put on the market by the Hauck Manufacturing Company, Brooklyn, N. Y. The illustration shows the device placed on a tire which is mounted on a special frame. At the top of the heater there is an adjustment for tightening the rings to take care of worn tires of a given size. The range of this adjustment is from one to three inches. A flexible metallic hose with couplings connects the ring with the heater so that it can be placed alongside of the track.



Suction Type Tire Heater with Portable Mounting

The burner preheats the compressed air from the supply line while it is passing through the heating coil in the fire box and then through the perforated ring on the tire. Preheating takes about two minutes. Then the oil supply valve at the injector is opened and vapor is emitted from the numerous perforations in the ring. This will ignite instantly by the use of a wick torch and sharp bluish-red flames like those of a gas burner are produced. There is no pressure on the oil and kerosene or a light fuel oil may be used.

The steel tank is of 20 gallons capacity with a filler cup and strainer. The tank and the burners are connected with seamless copper tubing. The burner is attached to a standard fire-brick lined sheet steel combustion box containing a steel pipe coil. It is mounted on two 20-in. and one 7-in. wheels which have 2-in. faces.

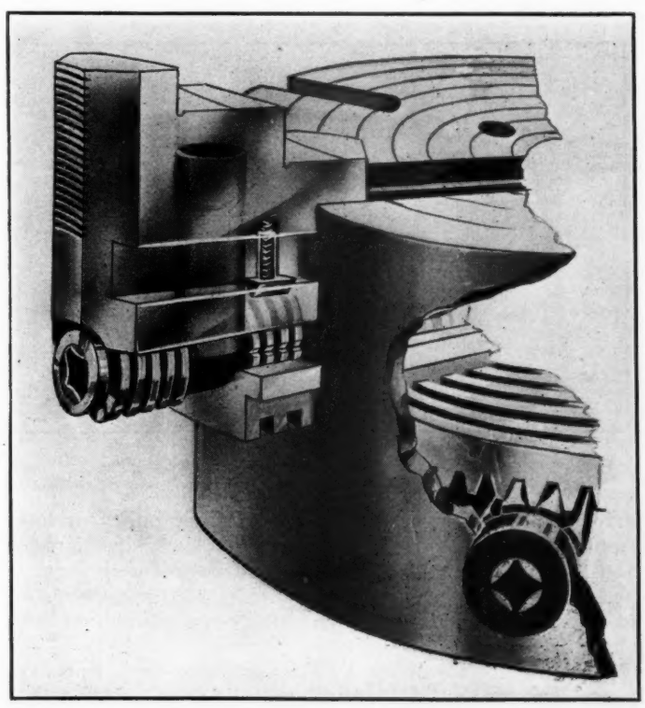
Cushman Tri-Plex Lathe Chuck

A NEW chuck has been placed on the market by the Cushman Chuck Company, Hartford, Conn., which is claimed to be the only chuck having both universal and independent movement of the jaws that indicates automatically when the jaws have found a common center.

At the base of each jaw is a hardened chrome-nickel steel screw, and a hard steel thrust bearing seated in the jaw encircles each screw. The screws engage steel racks beneath them, and the lower surfaces of the racks mesh in a scroll. When the scroll is revolved by a pinion gear, all the racks are carried concentrically forward or back.

The pitch of the screws carry the jaws on their racks exactly 1/5 in. in a full revolution. There is a V-shaped groove on each screw and in each jaw a spring index pin. As the screw is turned the index pin rides over it until it engages the groove. As the pin clicks into place after a full turn of the wrench, the operator knows he has moved the jaw exactly 0.2 in. The index pin will ride in and out of the groove without forming more than a slightly noticeable obstruction.

To change the chuck from concentric to eccentric action, turn the screw of the jaw to be adjusted with a wrench. All that is necessary to make the chuck concentric is to turn each screw whose jaw has been given an eccentric position until the index pin clicks into the slot of the screw, observing at the same time that the ends of all jaws are in approximately like relationship to the same circular observation line on the face of the chuck body. It is claimed that the chuck will then be concentrically true within .005 in. and no testing is necessary.



Lathe Chuck Which Indicates Automatically When the Jaws Have Found a Common Center

The body of the chuck is of gray iron, of one piece and formed like a truss. The jaws are of steel and, in connection with the individual racks, are reversible. All surfaces are hard, and being ground to standard gage, the jaws are interchangeable with others of corresponding sizes. The thrust bearings are self-alining and of improved design. The scrolls are of steel and the pinion gears of alloy steel and heat treated.

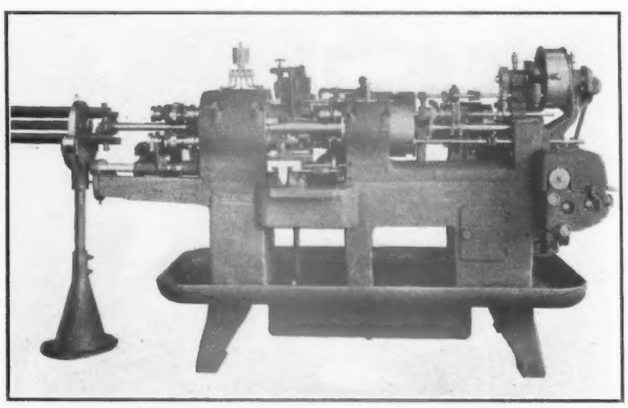
Cleveland Multiple Spindle Automatic

THERE are certain jobs which can be profitably handled on an automatic single spindle machine and there are other operations where the demand for high rates of output requires the work to be produced on the multiple spindle type. Recognizing this fact, the Cleveland Automatic Machine Company, Cleveland, Ohio, has developed a four-spindle automatic.

Certain features of the Cleveland Model A machine have been incorporated in the new multiple spindle design. This is notably true in the location and style of cams, etc. As a result, any operator who has become accustomed to operating Cleveland single spindle machines will find no difficulty in handling the multiple spindle type. With the exception of threading tools, the auxiliary tooling equipment is also interchangeable between the single and the multiple spindle machines. For companies operating both types of machines this not only simplifies the problem of handling tools, but also effects an economy through reducing investment and through keeping tools more constantly employed than would otherwise be the case.

Special attention has been paid to the elimination of all unnecessary complications of mechanical movement. As a result the mechanism is simple and all cams and adjustments have been located so that they can be easily seen and reached by the operator. Cams of different pitch and length can be used on the turret drum for handling pieces of various lengths. On the 7/8-in. size 5 in. is the maximum milling length and work up to 7 in. in length can be handled where the milling stroke does not exceed 3½ in. Where the work is of such a character that threading is not required a simplified machine can be furnished without threading mechanism.

The automatic can be arranged for either single pulley

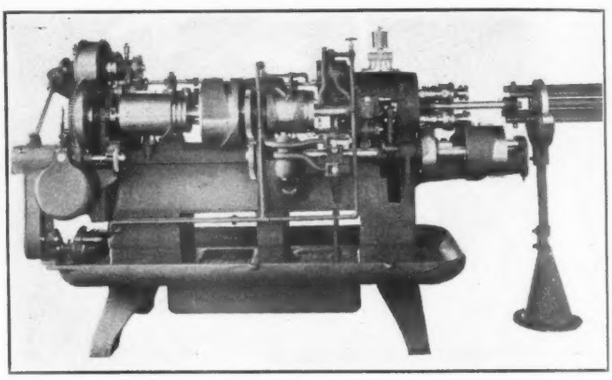


Cleveland Four Spindle Automatic

drive or electric motor drive. Where single pulley drive is employed, the pulley is 3 in. face width by 22 in. diameter and for the electric drive a 5 h.p. motor is employed, running at 1,750 r.p.m. The motor is attached by bolting a base plate to the bed arm of the machine, with power transmitted by a chain drive.

The spindles are driven by a center shaft which transmits power through hardened helical gears and seven changes of speed are provided by means of change gears. A new type of compression collar and balanced chuck operating finger are used. The chuck opening and closing slide is operated direct from the cam shaft and cams without levers, this combination providing a simple and efficient chucking mechanism. Each chuck hood is covered by an individual cast iron guard, thus protecting the hoods and preventing the cutting oil from flying when the spindles are running at high speeds.

Two slides operate the feed tubes, which are controlled direct from the cam shaft and cams without any intermediate levers, and the camming is so arranged that the tubes are al-



Rear View of the Cleveland Multiple Spindle Automatic

ways picked up by the feed slide regardless of their longitudinal position. Spring action is used for feeding the stock. The gage stop swings up to meet the bar stock as it is fed outward and then drops back out of the way. Bushings are provided to suit the reel stock tubes according to the diameter of the stock that is being handled, and the reel is rotated by means of a driver carried on a bar attached to the rear end of the spindle cylinder.

The indexing mechanism consists of a Geneva movement engaging the cylinder between the spindle bearings. Locking is accomplished by a heavy flat wedge operated by the indexing arm. A hand lever may be attached for drawing the wedge to rotate the spindle turret by hand while setting up and changing chucks.

The first and second positions are at the front, while the threading and the accelerating spindles are in the rear. This arrangement provides the maximum convenience in setting up box tools. A noteworthy feature of the tool turret arrangement is the provision of an independent tool spindle in the fourth position. By means of this arrangement, any tooling operation may be performed and completed in this position before the other tools have completed their work. The feed of this independent spindle may be accelerated or reduced to more or less than twice that of the tool turret, thus reaming or finish-turning the total length of work covered by the first and second position tools and receding from the work before the other tools have reached the ends of their cutting strokes and without delaying the operation of the cut-off tool.

Three cross slides are provided as regular equipment for the performance of rough and finish forming operations instead of the double deck posts which are commonly used; there is a fourth slide which may be used as a special attachment where it is required. The spindle cylinder is provided with individual cross slide stops for use on each spindle.

Levers are used to operate the cross slides which are short and strong and located where they are readily accessible for adjustment. Each slide has its individual cam, and can be moved to the work in any position.

The cam shaft is readily accessible for setting different cams and at the same time out of the way of chips and cutting oil. A safety pin is provided in the worm wheel which will shear off in case of any interference or overload on any of the cam movements and stop the tool turret and all of the cross slides before damage has been done.

The tool turret consists of a heavy cylinder made of hard cast iron mounted in a turret head bearing and also sliding on the hardened and ground steel center tube, which is supported in a fixed bearing back of the turret and at the opposite end in the spindle cylinder. This type of turret affords a solid tool support.

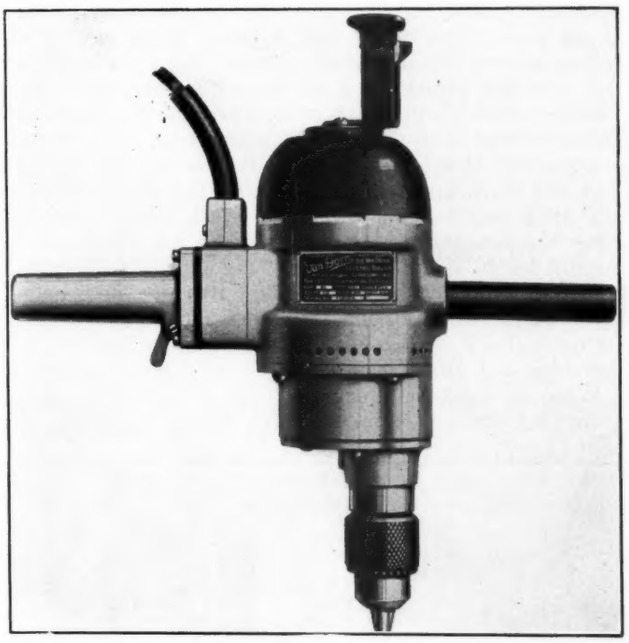
The 7/8-in. machine has a capacity for handling round stock up to 7/8 in. diameter, hexagon stock up to 3/4 in. and square stock up to 5/8 in. The floor space occupied is 36 in. by 96 in. and the weight of the machine is 4,700 lb.

Van Dorn Electric Motor

AN electric motor adaptable to production and intermittent service has been added to its family of electric tools by the Van Dorn Electric Tool Company, Cleveland, Ohio. The armature is provided with an extra large shaft which runs in an oversized bearing correctly mounted. The steel bearing retainers are cast in the aluminum and provisions are made for locking the inner races to the shaft at both ends. The ends of the shaft are provided with felt washers to retain the lubricant. They are confined by steel washers to prevent them from getting into the bearing. An alloy steel thrust bearing is provided for the spindle.

The drill is controlled by a semi-automatic switch which gives a quick make and break control. It is case lined with asbestos. The insulated motor is tested and rated to meet various standardization rules and is conservative in speed. One of the features on the drill is the strong construction of the motor housing. The new design brush holders are provided with a pigtail. This eliminates soldered connections, which makes the motor easily accessible for repairs. At the top of the drill are two screws which permit the removal of the spade handle and the top head for attention to the brushes and the top bearing.

The gears are cut and hardened and assembled with ground fits and oversize keys. The armature pin is removable and is made from alloy steel. The teeth are formed to give maximum strength and smooth operation. The motor may be run on either alternating or direct current.



Electric Motor Equipped with Ball Bearings and Alloy Steel Parts Throughout

Duplex Locomotive Rod Boring Machines

THE Newton Machine Tool Works of the Consolidated Machine Tool Corporation of America, Wilmington, Del., has recently redesigned and placed on the market a new type of heavy duty duplex locomotive rod boring machine. The standard machine is equipped with a plain table, but the machine is also made with an extended cross rail and auxiliary drop table at the end of the bed, which has a 4-in. in and out adjustment, thereby adapting the machine for the boring and reaming of the taper fit in crossheads.

The spindle is machined from an open-hearth hammered steel forging. The end of it is increased in diameter, which is 8½ in., and is fitted with a No. 7 Morse taper hole with a key slot and a draft slot, in addition to a face keyway for driving directly at the cutting point. It is counterbalanced by a ring counterweight suspended on chains. The spindle sleeve, which is machined from a steel forging, is 6½ in. outside diameter, and is fitted with bronze bushings and roller thrust bearings. It is provided with a rack for feed. Each spindle is independently operated, driven by a separate motor through the back gears and bronze spiral gear ring meshing with a hardened steel pinion which is fitted with roller thrust bearings and fully enclosed to run in oil. The bearings in the drive train are all bronze-bushed and all thrusts are taken up by roller bearings.

When the machine is arranged for constant speed motor drive, twelve changes of speed are provided by the use of a six-change gear box in conjunction with a two-speed spindle head. Six changes of feed are obtained with an even ratio of pick-off gears through a six-change sliding gear box, which are reduced through worm and worm wheel and a positive hardened steel jaw-type clutch to the rack pinion. Additional feeds are obtainable by the use of other pick-off gears which are furnished as extra equipment. In addition to hand adjustment and power down feed to the spindle, power quick return is also provided through a metal cone friction, which is operated by the same lever that engages the feed, and is conveniently located on the front of the saddle.

The driving gears are either of bronze or of hardened steel, fully enclosed to run in oil. The feed gears are either bronze or steel and the essential gears are hardened and fully enclosed to run in oil.

The spindle saddles are 35¼ in. in length and each is independently adjustable for positioning by a large hand wheel through reduction gears and rack and pinion, at the

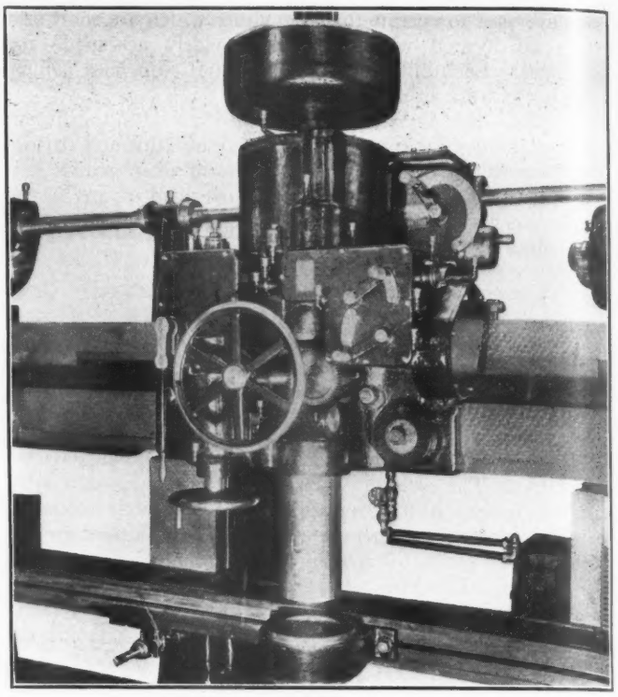
front of the head. They are rigidly clamped to the cross rail by a special form of binding gib adjusted by three bolts from the front. Taper gibs are used to compensate for wear. A one-inch pin extending one inch below the head, central with the spindle, on which is scribed a deep center line, facilitates the adjustment of the heads to exact centers by the use of either the fixed gages or trams, which are used for laying off the rods.

The cross rail is a one-piece box section casting, 21¼ in. wide overall. It is bolted and dowelled to the three columns or uprights. The uprights are of box section, 11 in. wide and 32¼ in. deep at the base, and are bolted and dowelled to each end and the center of the bed.

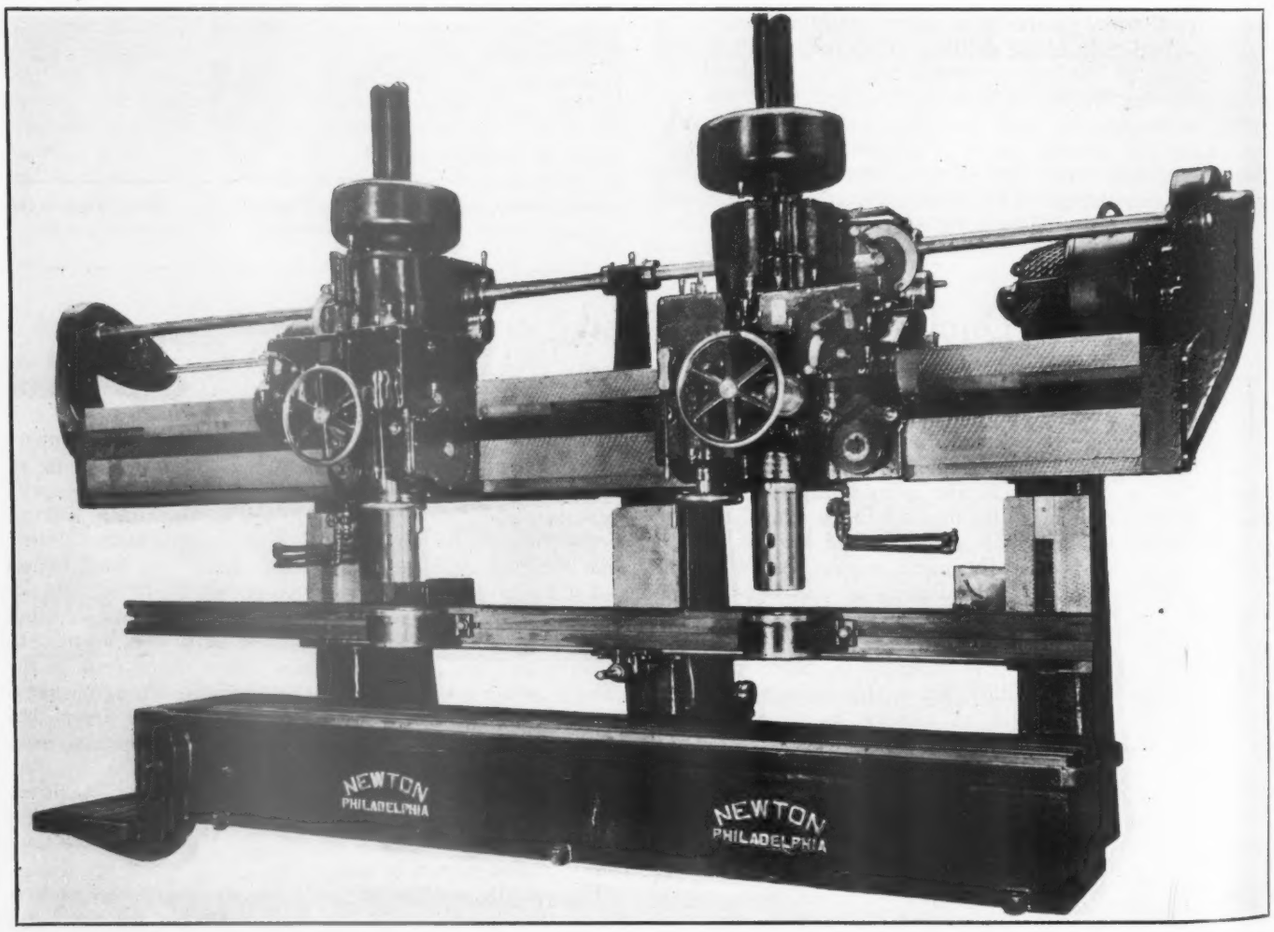
Both an intermediate spindle support and a lower arbor support are included in the standard equipment of the machine. The intermediate spindle support is in the form of an angle plate, bolted and dowelled to the saddle and resting against the under side of the cross rail, and when the spindle is positioned it is clamped to the cross rail by means of bolts fitted in T-slots. A bearing having an 8½-in. diameter hole in the bushing is bolted to this support and is adjustable vertically for varying heights of work.

A slot is machined in the center of the table, into which are fitted two bushings with three-inch holes, providing lower supports for the boring bars which are adjustable for the full length of the table. The base and the table casting is a box section, 22½ in. in height from the floor with a chip pan extending around both sides and the front, at the bottom. Inside of the base is cast a sloping wall so that the chips and lubricant gravitate to the front for removal.

When the machine is equipped with a plain table, it has a working surface 24 in. in width, 14 ft. in length, with two T-slots machined from the solid and an oil pan three inches wide and six inches deep, completely surrounding



Locomotive Rod Boring Machine Showing Construction of Spindle Saddle and Compactness of the Operating Mechanism



Duplex Rod Boring Machine Specially Equipped with Intermediate Support Bearings and an Auxiliary Drop Table at the End of the Bed

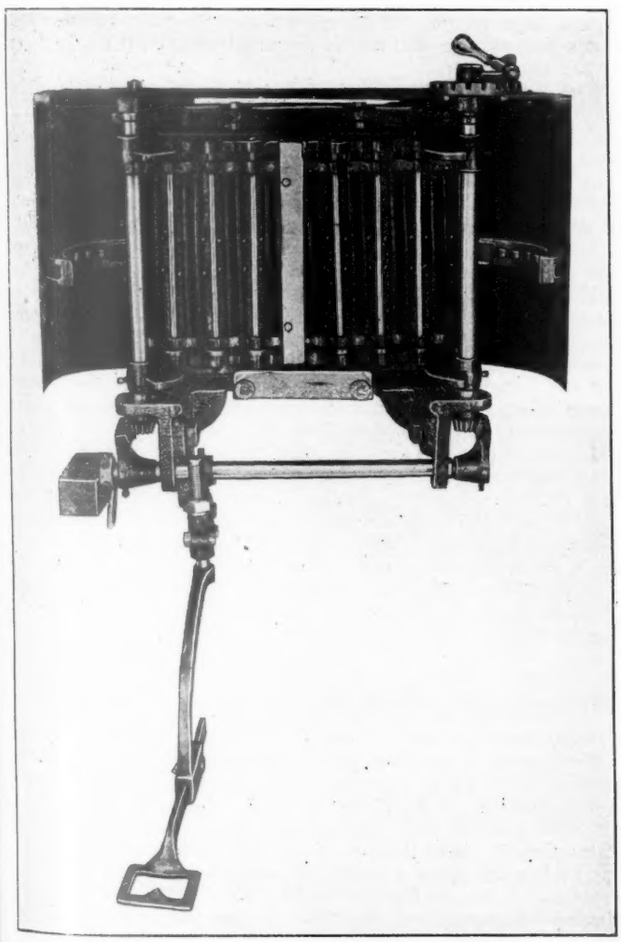
the table for draining off the lubricant. When required, an auxiliary work table, which facilitates the reaming of crossheads, etc., can be furnished. It is a one-piece casting, fitted to scraped bearings on the end of the base, and has a four-inch adjustment at right angles to the direction of travel of the saddles, with provision for clamping in position. The cutter lubricant drains from the oil pan around the table into a reservoir contained within the base, from which it is pumped directly to each spindle by a separate pump with all necessary connections furnished as standard equipment.

All operating parts, except the drive shaft on top of the machine and the spindle, are fully enclosed so that the machine will meet with the most rigid safety requirements.

When the machine is arranged for a constant speed motor drive, two 15-hp. 900 r.p.m. motors are required. They are mounted and bolted to pads on the rear of the gear boxes, to which they are directly connected by gearing. When the machine is arranged for variable speed motor drive, two 15-hp. 400 to 1,600 r.p.m. motors are required, which are mounted on the tops of the end columns and geared directly to the main drive shaft, thereby eliminating the gear boxes.

Revolving Locomotive Fire Door

A LOCOMOTIVE fire-door constructed on the principle of a roll-top desk has been designed by Frank Matthews, Montreal, Canada. It is operated by its own mechanism without the aid or use of air, steam or electricity, thereby relieving the over-taxed pressure on the air pumps.



Locomotive Firedoor Operated by its Own Mechanism Without the Aid or Use of Air

The door is strongly and peculiarly constructed of steel and cannot be blown open by an internal explosion. The front is made of eight panels, four on either side. The inside and outside panels are made of steel. The middle plate is made of asbestos and the whole is riveted together. This construction tends to make the door cool.

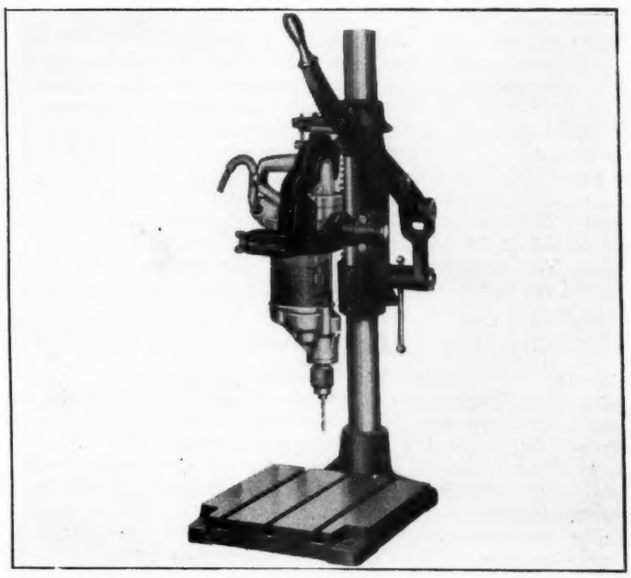
The top covering and the side wings act as deflectors, throwing the glare down to the floor of the cab enabling the engineman to see his signals more clearly at night, especially in inclement weather.

It is operated by a foot pedal entirely above and free from the deck plate, which is responsive to the slightest touch of the fireman's foot; the necessary forward movement of the body in firing causes the door to fly open. The natural backward movement of the body brings the balance weight into action and quickly closes the door. By a slight pressure on the foot pedal the fireman can open the door any desired distance in order to observe his fire. By using the hand operating mechanism at the top of the door, it can be held at any opening desired in order to observe the fire.

Hisey Bench Drill Stand

THE Hisey-Wolf Machine Co., Cincinnati, Ohio, has added to its list of portable tools a bench drilling stand equipped with a lever feed. It will hold all portable Hisey drilling machines up to and including the 5/8-in. size. The illustration shows the stand supplied with the adapter required with the 1/4-in. and 5/16-in. drills.

The stand is fitted with an adjustable depth drilling stop which is convenient in producing duplicate work. The design of the stand is such that the drill can be attached without removing any part. The equipment consists of a portable sensitive drill press that can be operated from a lamp socket. A few of the specifications are as follows: length of feed, by means of the lever, 4½ in.; maximum distance from the top of the base to the drill chuck, 17 in.; distance from the center of the drill spindle to the column, 6½ in.; size of the base, 12 in. by 11 in.; diameter of the column, 2 in.; net weight of the stand 90 lb.



Bench Drill Stand with a Hand Lever Feed

GENERAL NEWS

The Pennsylvania Railroad Club was organized on September 16 at Indianapolis, Ind., to promote fellowship among employees of the Indianapolis division. The membership takes in all classes from gang foremen to the highest operating officers. The organization work has been under the direction of Paul A. Kriese, safety agent and publicity manager of the road. The club will meet once each month.

The Safety Section of the American Railway Association proposes to have a Code of Safety Rules; and the Committee of Direction has appointed the following committee to submit a draft:—F. M. Metcalfe, superintendent of safety, Northern Pacific; H. A. Adams, assistant to general manager, Union Pacific; J. A. McNally, inspector, Wabash; M. McKernan, superintendent of safety, Missouri Pacific and W. H. Elliott, signal engineer, New York Central (Eastern lines).

Car Service Division Report

The report of the Car Service Division submitted to the Board of Directors of the American Railway Association on September 19, showed that on September 1, freight cars in need of repairs totaled 210,109, or 9.2 per cent of the number on line, compared with 175,327, or 7.7 per cent, on the same date last year. Of locomotives, 15 per cent of the number on line were in need of heavy repairs, compared with 14.7 per cent last year, and 1.9 per cent awaited light repairs, compared with 1.8 per cent last year.

Surplus freight cars in serviceable condition on September 1, totaled 231,677, compared with 66,559 on the same date last year.

Railroad Wage Statistics for June

The number of employees reported by Class I railroads for the month of June, 1924, was 1,770,565, a decrease of 163,364 or 8.4 per cent as compared with the returns for the same month last year, according to the Interstate Commerce Commission's monthly bulletin of wage statistics. The total amount of compensaion decreased $29,632,263 or 11.4 per cent. While each reporting group shows a marked reduction, the principal decreases occurred in the maintenance of equipment and train and engine service groups.

Compared with the returns for the previous month, total decreased 21,939 or 1.2 per cent, and the total compensation decreased $10,533,603 or 4.4 per cent. June had one less working day than May. The employment in the train and engine service group reached the lowest point since August, 1922.

Court News

Safety Appliance Act—Locomotive in Roundhouse for Repairs.—The Circuit Court of Appeals, Sixth Circuit, holds that the Safety Appliance Act, §2, is applicable to all vehicles used on any interstate railroad, whether they are engaged in interstate commerce or not. The test of liability under this act is not to be confused with that under the federal Employers' Liability Act, where the statutory test is whether the employee is at the time engaged in interstate commerce. He is deemed to be so employed if he is working upon an "instrumentality of interstate commerce"; and a car or engine is sometimes deemed to continue to be such instrumentality, even though it is not at the present time active therein. In actions under the Safety Appliance Act the statutory criterion is whether the car is "in use" "on its line." It is therefore held that a locomotive which is at rest at a repair point after the hauling to that point has stopped is not within the act. The accident in this case happened to a machinist who fell from the engine while it was in the roundhouse by slipping on some oil which had been left on the running board after the engine had been sprayed. —Baltimore & Ohio v. Hoover, 297 Fed. 919.

Defective Coupler Not Proximate Cause of Injury.—The New York Appellate Division holds that the existence of a defective coupler, to be a basis for either negligence or a violation of the Safety Appliance Act, must be a proximate cause of the injury; and where a collision of moving cars against the car which struck plaintiff was unintended, and no part of the operation required the presence of a coupler, evidence as to a defective coupler on the car should have been excluded.—Hodgert v. D. L. & W., 202 N. Y. Supp. 793.

Safety Appliance Act—Railroad's Duty Not Affected by Strike.—The federal district court for northern Georgia holds that the impossibility of inspection and repair of cars owing to a strike and state of violence approaching war is no defense to an action for penalties incurred in using cars with defective safety appliances, the duty imposed by the act being an absolute one. Whatever the cause that prevents the making of repairs, the carrier must cease to use the cars, though its trains stop, or must suffer the consequences fixed by law. If under the unusual circumstances the penalties incurred by the letter of the law ought not to be exacted, the executive probably has the power to remit them under the provisions of U. S. Revised Statutes, §5292. The carrier must seek a remedy there.—U. S. v. Western & Atlantic, 297 Fed. 482.

Census of the Car Industry

The Department of Commerce announces that, according to the data collected at the biennial census of manufactures, 1923, there was a large increase in the manufacture of railroad cars, both steam and electric, in 1923, as compared with 1921, the last preceding census year.

The establishments engaged primarily in the manufacture of railroad cars (steam and electric) in 1923 produced 1,837 steam-railroad passenger cars, valued at $40,252,394; 164,969 steam-railroad freight and other non-passenger cars, valued at $329,672,548; 2,767 electric-railroad passenger cars, valued at $25,695,757; and 115 freight and other non-passenger electric railroad cars, valued at $488,956; together with other products to the value of $207,485,686; making a total of $603,595,341, an increase of 77.2 per cent as compared with $340,536,225 in 1921.

The combined number of cars manufactured by both classes of establishments advanced from 54,033 in 1921 to 169,688 in 1923, the rate of increase being 214 per cent; and their combined value increased from $186,903,128 to $396,109,655 at the rate of 111.9 per cent. In addition, cars, parts and repairs are made to some extent by steam and electric-railroad repair shops and by a few establishments engaged primarily in other industries. The number and value of cars and the value of parts and repairs made in such establishments in 1921 was reported as follows: 5,230 steam-railroad cars valued at $13,722,001, 179 electric-railroad cars valued at $1,313,827, and parts and repairs valued at $330,576. The corresponding figures for 1923 have not yet been ascertained, but will be shown in the final reports of the present census.

Of the 138 establishments reporting for 1923, 130 were engaged primarily in the manufacture of steam-railroad cars and 8 in the manufacture of electric-railroad cars.

International Report on Car Coupling Accidents

Automatic Car Couplings and the Safety of Railway Workers, is the title of a pamphlet which has been issued by the International Labor Office (Geneva, Switzerland), embodying a study of the statistics of fatal and non-fatal injuries to railway employees in coupling cars, through a series of years, in the United States, Canada, Great Britain and nine other countries. This study was made pursuant to a resolution which was adopted at the International Labor conference last October, with a view to seeing whether an international agreement in the matter would be desirable.

The introduction of automatic couplers on freight cars in the United States thirty years ago reduced the total annual injuries

to employees approximately 80 per cent. This is past history. The report goes on to compare present conditions in different countries, and finds that the risk to employees in Great Britain and Ireland is very much lower than in the United States, judged by the governmental reports of casualties; but in most of the countries of continental Europe, as expressed by the corresponding percentages, the risk is higher than either in the United Kingdom or in the United States. Comparisons have been made with casualties to miners and men in other hazardous industries, and the conclusion is reached that the occupational risk of men performing coupling and uncoupling operations is exceedingly high. An estimate of this risk, which seems to include all of the countries in which studies were made, gives the average as from 1½ to 2½ killed and from 50 to 60 injured, annually, per thousand shunting operators. This last term evidently is meant to include all employees exposed to risk in car coupling.

The report omits to mention the obvious fact that, so far as risk of bodily injury is concerned, the automatic couplers used in America and the non-automatic chain couplings in use in Europe are alike; in that, with neither kind of couplings are the switchmen or shunters required to go between the cars except when both of the cars to be coupled (or uncoupled) are motionless.

MEETINGS AND CONVENTIONS

International Railway Congress to Meet in London on June 22, 1925

Word has been received to the effect that the next meeting of the International Railway Congress will convene in London on June 22, 1925. It is understood, but not officially confirmed, that at the same time the British railways will celebrate the centennial of railways in that country. The program for the congress has not yet been announced.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room, 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

AMERICAN RAILWAY ASSOCIATION, DIVISION V.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

DIVISION V.—EQUIPMENT PAINTING DIVISION.—V. R. Hawthorne, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York.

AMERICAN RAILWAY TOOL FOREMAN'S ASSOCIATION.—J. A. Duca, tool foreman, C. R. I. & P., Shawnee, Okla.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 23 West Forty-third St., New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill. Annual meeting October 20-24, Hotel La Salle, Chicago.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Sharron St., Montreal, Que. Regular meetings second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—R. E. Giger, 721 North 23rd street, E. St. Louis, Ill. Meetings, first Tuesday in month, except June, July and August, at the American Hotel Annex, St. Louis.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings second Thursday, January to November. Interim meetings second Thursday, February, April, June, Hotel Statler, Buffalo, N. Y. Next meeting October 9. Moving pictures will be shown on "The Three Atoms," this having to do with fuel economy; to be followed by a talk on the same subject by W. L. Robinson, superintendent fuel and locomotive performance, Baltimore & Ohio. Pictures made for B. & O. and shown at a special meeting of the International Railway Fuel Association last April.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—A. S. Sternberg, Belt Railway, Clearing Station, Chicago.

CINCINNATI RAILWAY CLUB.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings second Tuesday, February, May, September and November.

CLEVELAND STEAM RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meeting first Monday each month at Hotel Cleveland, Public Square, Cleveland. Next meeting October 6. Paper on Air Brake Operation and Maintenance to Cars will be read by G. H. Higley, supervisor air brakes, Erie railroad.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. B. Hutchinson, 6000 Michigan Ave., Chicago, Ill.

INTERNATIONAL RAILWAY GENERAL FOREMAN'S ASSOCIATION.—William Hall, 1061 W. Wabash St., Winona, Minn.

MASTER BOILER MAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in month, except June, July, August and September, Copley-Plaza Hotel, Boston, Mass.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meeting third Friday of each month except June, July and August at 29 West Thirty-ninth St., New York. Next meeting Oct. 17. A paper on public relations will be presented by R. H. Newcomb, assistant to vice-president, N. Y., N. H. & H.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y. Regular meetings January, March, May, September and October.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings second Thursday in month, alternately in San Francisco and Oakland, Cal. Next meeting Oct. 16. Old timers' night. Papers on The Mechanical Department, The Operating Department, The First Peanut Butcher on the Central Pacific, and the Traffic Department, will be read by P. Sheedy, superintendent, motive power, Southern Pacific; W. J. Hunter, retired superintendent, Northern Pacific; E. S. Harrison, C. B. & Q., and W. R. Alberger, vice-president and general manager, Key System Transit Company, respectively.

RAILWAY CLUB OF GREENVILLE.—F. D. Castor, clerk, maintenance of way department, Bessemer & Lake Erie, Greenville, Pa. Meeting last Friday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, Union Station, St. Louis, Mo. Regular meetings second Friday in month, except June, July and August. Next meeting October 10. Paper on Locomotive Feedwater Heaters will be read by J. M. Lammedee, Chicago.

SOUTHEASTERN CARMEN'S INTERCHANGE ASSOCIATION.—J. E. Rubley, Southern railway shops, Atlanta, Ga.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

WESTERN RAILWAY CLUB.—Bruce V. Crandall, 138 West Madison street, Chicago. Meetings third Monday in each month, except June, July and August.

LOCOMOTIVES ORDERED—INSTALLED AND RETIRED

Month—1923	Installed during month	Retired during month	Owned at end of month	Aggregate tractive effort	Building in R. R. shops
September	384	260	64,720	2,506,469,051	7
October	408	301	64,827	2,520,200,846	15
November	333	282	64,879	2,532,085,380	14
December	333	316	64,896	2,541,607,425	14
Full year 1923	4,037*	3,672	.....	.....	..
1924					
January	271	178	64,989	2,552,694,953	14
February	214	175	65,029	2,559,519,253	10
March	176	181	64,911	2,560,076,766	7
April	97	112	64,896	2,561,362,769	11
May	153	107	64,942	2,565,706,413	10
June	160	178	64,924	2,569,121,875	72
July	197	113	65,008	2,576,433,377	63

Total for 7 months, 1,268.

Figures as to installations and retirements prepared by Car Service Division, A. R. A., published in form C. S. 56A-1. Figures cover only those roads reporting to the Car Service Division. They include equipment received from builders and railroad shops. Figures of installations and retirements alike include also equipment rebuilt to an extent sufficiently so that under the accounting rules it must be retired and entered in the equipment statement as new equipment. Figure as to orders as given in first column of table is not therefore comparable with figures relating to installations given in succeeding columns.

*Corrected figure.

FREIGHT CAR REPAIR SITUATION

Date, 1923	Number freight cars on line	Cars awaiting repairs: Heavy	Light	Total	Per cent of cars awaiting repairs	Month	Cars repaired: Heavy	Light	Total
January 1	2,264,593	164,041	51,970	216,011	9.5				
April 1	2,296,997	154,302	52,010	206,312	9.0				
July 1	2,260,532	146,299	44,112	190,411	8.4	June	121,077	2,451,758	2,572,835
October 1	2,270,840	118,563	32,769	151,332	6.7	September	114,064	2,335,161	2,449,225
November 1	2,263,099	116,084	34,540	150,624	6.6	October	117,254	2,444,118	2,561,372
December 1	2,270,405	116,697	38,929	155,626	6.8	November	104,761	2,214,617	2,319,378
1924									
January 1	2,279,363	118,653	39,522	158,175	6.9	December	87,758	2,073,280	2,161,038
February 1	2,269,230	115,831	45,738	161,569	7.1	January	76,704	2,083,583	2,160,287
March 1	2,262,254	119,505	49,277	168,782	7.5	February	70,056	2,134,781	2,204,837
April 1	2,274,750	125,932	46,815	172,747	7.6	March	77,365	2,213,158	2,290,523
May 1	2,271,638	131,609	47,666	179,275	7.9	April	75,352	2,074,629	2,149,981
June 1	2,280,295	138,536	50,683	189,219	8.3	May	73,646	2,130,284	2,203,930
July 1	2,279,826	144,912	49,957	194,869	8.5	June	70,480	1,888,899	1,959,379
August 1	2,278,773	153,725	49,139	202,864	8.9	July	72,347	1,567,430	1,639,777
September 1	2,296,589	158,200	51,909	210,109	9.2	August	71,863	1,420,482	1,492,345

SUPPLY TRADE NOTES

The Southern Wheel Company, St. Louis, Mo., will enlarge its branch plant at Nevada, Ga.

George C. Billman has been elected president of the Charles C. Young Manufacturing Company, Jersey Shore, Pa.

Brinton Welser, assistant secretary and assistant sales manager of the Chain Belt Company, Chicago, has been elected secretary.

A. J. Stott, who has not been active in business for the past few years, is now affiliated with the Glidden Company, Cleveland, Ohio.

Gordon H. McCrae, manager of the London office of the Independent Pneumatic Tool Company, has been elected a vice-president of the company.

Hughes & Graul, 1313 Peoples Gas building, Chicago, have been appointed northwestern representatives of the Davis Brake Beam Company, Johnstown, Pa.

The Ohio Brass Company, Mansfield, Ohio, has moved its Philadelphia, Pa., office from the Witherspoon building to 1404 Packard building at Fifteenth and Chestnut streets.

R. W. Payne has been appointed southern sales agent of the Verona Tool Works, Pittsburgh, Pa., with headquarters at 613 Fifteenth street, N. W., Washington, D. C.

The Whiting Corporation has given a general contract to T. D. Hobson & Son, Harvey, Ill., for a one-story power house, 75 ft. by 75 ft., at Harvey, Ill., estimated to cost $40,000.

The Standard Stoker Company, Inc., New York, has recently opened a sales office at Richmond, Va., and W. R. Williams has been appointed district sales manager in charge of the new office.

J. W. Blackford has joined the sales force of the Torrington Company, Torrington, Conn. Mr. Blackford will handle the sale of that company's Dayton swaging machines and Torrington ball bearings.

B. N. Broido, who has been doing special consulting work for the Superheater Company, of New York and Chicago, has recently been appointed chief engineer of the industrial department of the company.

H. D. Rohman, of the R. C. S. Equipment Company, New York, has taken over the agency of the Electric Arc Cutting & Welding Company, Newark, N. J., for Taperod electrodes on interstate steam railways.

Clayton R. Burt, president and general manager of the Austin Machinery Corporation, Chicago, has been elected general manager of the Pratt & Whitney Company, Hartford, Conn., to succeed Bryant H. Blood, resigned.

The National Railway Appliance Company, of New York, with offices at Boston and Washington, and the Hegeman-Castle Corporation, of Chicago, have been appointed general sales agents of the Walter tractor snow-plow.

J. C. Shepherd has been appointed assistant general manager of sales of the Kansas City Bolt & Nut Company, with headquarters at Kansas City, Mo., and J. W. Anderson has been appointed assistant general manager of sales.

The Hanna Engineering Works, Chicago, is now represented in Minnesota, North Dakota, South Dakota, Iowa and the eastern portion of Nebraska by the George M. Kenyon Company, 116 East Fourth street, St. Paul, Minn.

The Southwest Sales & Equipment Company, Los Angeles, Cal., has been appointed representative for the Orton & Steinbrenner Company, Chicago, to handle the latter's products in southern California, Arizona and New Mexico.

The De Remer Blatchford Company, Railway Exchange building, Chicago, has been appointed direct mill representative for the Lockhart Iron & Steel Company, Pittsburgh, Pa., manufacturers of locomotive staybolts and engine bolt iron.

The George M. Kenyon Company, 116 East Fourth street, St. Paul, Minn., now represents the Hanna Engineering Works, Chicago, in the states of Minnesota, North Dakota, South Dakota, Iowa and the eastern portion of Nebraska.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, manufacturers of hollow and solid staybolts, has appointed the Tabson Company as its special representative in Illinois, with offices in the Railway Exchange building, Chicago.

The Butler Railway Supply Company, 122 South Michigan avenue, Chicago, has been formed to manufacture and sell side bearings, trucks and truck parts. The incorporators of the company are Vincent J. Burry, C. A. Woodman and O. S. Flath.

H. L. Woolfenden, district manager of the Allis-Chalmers Manufacturing Company, with headquarters at Denver, Colo., has resigned to take charge of sales promotion of the Scott Valve Manufacturing Company, with headquarters at Detroit, Mich.

Raynard F. Bohman is now general traffic manager of the Heywood-Wakefield Company, Boston, Mass. Mr. Bohman was formerly traffic manager of the Lloyd Manufacturing Company, Menominee, Mich., a subsidiary of the Heywood-Wakefield Company.

The Commercial Asbestos Corporation has been incorporated at Huntington, Ind., to manufacture railway installations and other asbestos products. The incorporators are E. W. Steinhart, Ft. Wayne, Ind., C. J. Higgins, Detroit, Mich., and R. J. Evans, Wabash, Ind.

L. P. Mercer, resident sales manager of the Parkesburg Iron Company, with headquarters at Chicago, has been appointed Chicago district representative of the Hall Draft Gear Corporation, with offices at 343 South Dearborn street, Chicago, and will hold both positions.

The Union Railway Equipment Company, Chicago, on September 16 discontinued its sales arrangement with the Commonwealth Supply Company, Richmond, Va., and in future all sales in the southeastern territory will be handled direct from the general office, Chicago.

The Transportation Devices Corporation, Indianapolis, Ind., manufacturers of automatic cut-off control for locomotives, has appointed the Lyman Tube & Supply Company, Ltd., Montreal, as its Canadian representative. This company has branch offices in Toronto and Vancouver.

The Pawling & Harnischfeger Company, Milwaukee, Wis., has appointed P. H. Sackett to represent the company in Minnesota, North Dakota and South Dakota. Mr. Sackett's headquarters will be at 3445 Hennepin avenue, Minneapolis, Minn., and he will handle all of the company's business in the territory stated above.

E. R. Mason, 1845 Grand Central Terminal, New York City, has been appointed district sales manager, in charge of sales in all the New England states, also in New York, New Jersey, Pennsylvania and Delaware, for Fairmont Railway Motors, Inc., Fairmont, Minn., manufacturers of section gang and inspection motor cars.

The E. L. Essley Machinery Company, Chicago, has taken over the exclusive agency in the Chicago and Milwaukee districts for the sale of the line of milling machines manufactured by the Rockford Milling Machine Company, Rockford, Ill., and the Sundstrand stub lathes and the Sundstrand manufacturing lathes made by the Rockford Tool Company, Rockford, Ill.

Percy M. Brotherhood, first vice-president of Manning, Maxwell & Moore, Inc., New York, is now consulting engineer; Frank J. Baumis, works manager of the Putnam Machine Company at Fitchburg, Mass., has been appointed vice-president of Manning Maxwell & Moore, Inc., in charge of the machinery department, with headquarters at New York, and Augustus Wood, who was chief engineer, is now works manager of the Putnam Machine Company, with headquarters at Fitchburg.

The American Refrigerator Transit Company has awarded contracts to Johns-Manville, Inc., New York, for hair material, and to the Celotex Company, of Chicago, for Celotex material, to be used in the insulation of 2,000 refrigerator cars. The Celotex material, in sheets one-half inch thick, will be applied to both the inside and outside of the framing of the side and end walls. It was erroneously reported in the September issue of the *Railway Mechanical Engineer* that the contract for all the insulating material was awarded to the Celotex Company.

The Waugh Draft Gear Company, Peoples Gas building, Chicago, manufacturer of draft gears and buffing devices, has been reorganized and its name has been changed to the Waugh Equipment Company. J. M. Waugh, president of the Waugh Draft Gear Company, has been elected chairman of the board of directors of the Waugh Equipment Company, and A. J. Tizzini, president of the Railway Improvement Company, New York, has also been elected president of the Waugh Equipment Company.

H. T. Heath has been appointed western department manager of the Hegeman-Castle Corporation of Chicago, owned and controlled by the National Railway Appliance Company of New York. Mr. Heath graduated from the Ohio State University in 1911, with degrees of M.E. and E.E. He served with the Westinghouse Electric & Manufacturing Co. for six and one-half years and joined the Economy Electric Devices Company in 1917 as sales representative of the middle west and southwestern territory.

The Ryan Car Company, Chicago, heretofore controlled by James M. Hopkins, president of the Ryan Car Company and chairman of the board of directors of the Camel Company, and W. W. Darrow, vice-president of the Camel Company, has been acquired by a syndicate, headed by John M. Burnham & Co., Chicago. William M. Ryan, formerly president of the Ryan Car Company and president of the Youngstown Steel Car Company, Niles, Ohio, has been elected president of the new company, and R. D. Bartlett will continue as secretary-treasurer and assistant to the president. T. H. Goodnow, vice-president of the Ryan Car Company, has resigned to become vice-president of the Camel Company, with headquarters at Chicago.

D. R. Arnold, whose appointment as vice-president of the Union Metal Products Company, with headquarters at Chicago, was announced in the August issue of the *Railway Mechanical Engineer*, was born in Dayton, O., and in 1906 entered the employ of the Barney & Smith Car Company, Dayton, O., where he held various positions. In 1911 he resigned from the sales department to become assistant to the chief engineer of the Canadian Car & Foundry Company, Montreal, Que., and in 1914 was transferred to the sales department. In 1916 he was appointed sales manager, which position he held until his recent appointment.

D. R. Arnold

H. P. Anderson has been appointed mechanical engineer of the Standard Stoker Company, Inc., with office at Erie, Pa. Mr. Anderson has had considerable experience in designing, pattern, foundry and machine shop practice. He is a graduate of Drexel Institute, Philadelphia. He served as mechanical engineer for four years with the Baldwin Locomotive Works, for one and one-half years with the Erie Railroad and for eleven years as mechanical engineer of the Wabash, from which road he went to the Missouri-Kansas-Texas as mechanical engineer. Mr. Anderson was promoted to superintendent of motive power and later mechanical assistant to chief operating officer, which latter position was abolished at the termination of its receivership.

P. R. Drenning has been retained by the Rogatchoff Company, Baltimore, Md., as consulting engineer and as sales manager in southern territory. Mr. Drenning was born at York, Pa., in 1891, is a graduate of the Baltimore Polytechnic. After serving as draftsman for the Baltimore Car & Foundry Company, he spent 11 years in the engineering and sales departments of the T. H. Symington Company. In July, 1923, he became vice-president of the Boyden Steel Corporation, in charge of engineering and sales. In July, 1924 he resigned to engage in consulting engineering, with offices at 902 Standard Oil building, Baltimore, where he is now located. He will continue as consulting engineer for the Boyden Steel Corporation, in addition to his duties with the Rogatchoff Company, in marketing the Rogatchoff crosshead adjustment.

TRADE PUBLICATIONS

DIE HEADS.—Land-Matic die head installation views are featured in a 12-page booklet recently issued by the Landis Machine Company, Waynesboro, Pa.

POWER REVERSE GEAR.—The Ragonnet power reverse gear, Type B, is illustrated and described in detail in Bulletins Nos. 227-A and 228-A, recently issued by the Franklin Railway Supply Company, New York.

CHAINS AND GEARS.—A 224-page catalogue, completely listing chains, sprockets and gears for elevating, conveying and the transmission of power, has been issued by the Stephens-Adamson Manufacturing Company, Aurora, Ill.

VALVE GEARS.—In order to facilitate the maintenance of Baker locomotive valve gears, the Pilliod Company, Swanton, Ohio, has issued a 79-page parts catalogue. The various types of Baker valve gear are illustrated, and each of the parts entering into their construction is numbered for easy reference when replacing worn or broken members.

LEAKAGE INDICATOR.—The Westinghouse Air Brake Company, Pittsburgh, Pa., has issued circular No. 1072, descriptive of its leakage indicator for 3-T triple valve test rack. The principle employed in this testing device is the balancing of a static head of a column of water against the pressure built up in a definite size chamber into which leakage from the triple valve is entering.

PACKING PROBLEMS SOLVED BY WIRELESS.—A four-page Mystic Oracle, by means of which enginehouse packing problems may be readily solved, has been issued by the Garlock Packing Company, Palmyra, N. Y. The disk on the third page of the folder is turned until the question to be answered is directly under the pointer, "What Packing Should Be Used." The folder is then closed, and the magnetized arrow on the outer page finds the answer.

FEED WATER HEATERS.—A 20-in. by 43½-in. chart illustrating through colors the principle of utilizing waste heat for preheating boiler feedwater through the medium of the Elesco non-contact feed water heater, has been issued by the Superheater Company, New York. A facsimile of the chart also is shown on Folder A. Two other folders, B and C, discuss in concise form the advantages of heating boiler feed water and illustrate units of Elesco equipment and various installations.

ELECTRIC FANS.—A comprehensive review of the use of electric fans for blowing, exhausting, ventilating, cooling and drying is contained in a 16-page booklet just issued by the Buffalo Forge Company, Buffalo, N. Y. The subject matter is confined to direct connected units, including descriptions of small disk or propellor fans, multiblade type fans for heating and ventilating, stoker units, pressure blowers, mill exhausters and electric forge blowers, and is amply illustrated with views of installations in various industries.

PNEUMATIC TOOL REPAIR PARTS.—A complete repair part catalogue showing each part that enters into the construction of Thor pneumatic tools and the interchangeability of parts from one tool to another, has been published by the Independent Pneumatic Tool Company, Chicago. Considerable tabulated matter, giving symbol numbers, name and description of part, and showing the different sizes of Thor tools on which parts interchange, has been compiled in order to give the pneumatic tool user a better understanding of the parts in the various tools and thus enable him to keep a tool in service that might otherwise have to lie idle awaiting repair parts from the factory.

ELECTRICAL EQUIPMENT.—"Electrical Equipment for Railroad Shops" is the title of publication No. C-1661, which is being issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. It contains pertinent information and general principles, serving as a guide in the selection of electrical equipment for engine and car shops, engine terminals, freight terminals and passenger stations. The results of the application of individual motor drive and the extensive use made of magnetic control, both automatic and semi-automatic, in railway shops are described in detail and by illustrations. A description of the arc welding process and its uses in track reclamation is also given.

PERSONAL MENTION

General

E. Gelzer, mechanical engineer of the Chicago Great Western, with headquarters at Oelwein, Iowa, has resigned.

Frank J. Regan has been appointed fuel supervisor of the Northern Pacific, with headquarters at Duluth, Minn., succeeding Melvin Montgomery, deceased.

T. E. McDonald, road foreman of engines of the Pennsylvania, with headquarters at Logansport, Ind., has been transferred to the office of the general superintendent of motive power at Chicago.

H. P. Allstrand, master mechanic of the Chicago & North Western, at Boone, Iowa, has been promoted to general supervisor of efficiency, with headquarters at Chicago, a newly created position.

D. H. Jenness, acting assistant road foreman of engines of the Fort Wayne division of the Pennsylvania, has been promoted to road foreman of engines of the Logansport division, with headquarters at Logansport, Ind., succeeding T. E. McDonald.

Master Mechanics and Road Foremen

W. H. Halsey, master mechanic of the Chicago & North Western, with headquarters at Belle Plaine, Iowa, has been transferred to Boone, Iowa, succeeding H. P. Allstrand.

Car Department

William J. Cain, for the past 18 years a foreman in the car department of the New York Central at West Albany, N. Y., has been retired. Mr. Cain, who was born in Albany in August, 1854, had been in the employ of the New York Central for 43 years.

Shop and Enginehouse

Harry Laughlin, enginehouse foreman of the Pennsylvania at Elmira, N. Y., has been transferred to Sharpsburg, Pa.

J. F. Hunt, Jr., gang foreman of the Pennsylvania at Elmira, N. Y., has been appointed motive power inspector of the shops at Meadows, N. J.

Otto Burgert, general foreman of the Pennsylvania at Rose Lake, Ill., has been appointed enginehouse foreman, with headquarters at Effingham, Ill. The position of general foreman at Rose Lake has been abolished.

Purchasing and Stores

J. E. Bogan has been appointed division storekeeper of the Missouri Pacific, with headquarters at Nevada, Mo.

W. O. McClellan has been appointed division storekeeper of the Missouri Pacific at Coffeyville, Kans., succeeding C. W. Krumm.

L. L. Studer, division storekeeper of the Missouri Pacific, with headquarters at Osawatomie, Kans., has been transferred to Kansas City, succeeding J. J. Fogarty.

C. W. Krumm, division storekeeper of the Missouri Pacific, with headquarters at Coffeyville, Kans., has been transferred to Osawatomie, succeeding L. L. Studer.

J. J. Fogarty, division storekeeper on the Missouri Pacific at Kansas City, Mo., has been promoted to district storekeeper, with headquarters at De Soto, Mo., succeeding J. E. Bogan.

Clyde Cocke, assistant purchasing agent of the Norfolk & Western, with headquarters at Roanoke, Va., has been appointed purchasing agent, succeeding J. H. Clemmitt, deceased. Mr. Cocke was born on July 13, 1893, and entered the employ of the Norfolk & Western as a messenger boy in the summer of 1909. The following winter he attended the National Business College in Roanoke, returning in June, 1910, to the Norfolk & Western as a clerk in the purchasing department. In April, 1917, he was furloughed for military service and after two years' service overseas with the Rainbow Division, he resumed his duties in the purchasing department. In August, 1922, he was made chief clerk to the purchasing agent, and in April of this year he was promoted to assistant purchasing agent.

Obituary

William Aird, well known in railway and locomotive circles in Canada, died at Barrie, Ont., last week. He was born in Scotland and received his early education in France. Coming to Canada with his father, who was employed in the construction of the Victoria bridge at Montreal, Mr. Aird entered the Point St. Charles (Montreal) shops of the Grand Trunk. Later he became shop foreman at Stratford, Ont.; then master mechanic. Later he resigned that position to become superintendent of the Canadian Locomotive Works at Kingston, Ont., a position he held until his retirement ten years ago.

Charles R. Couchman, who resigned as assistant purchasing agent and general storekeeper of the Pere Marquette in 1920 to become purchasing agent for the Detroit City Gas Company, Detroit, Mich., died suddenly at his summer home in Amherstberg, Ont., on August 16. Mr. Couchman entered railway service in 1892 as a messenger boy in the stores department of the Flint & Pere Marquette (now the Pere Marquette), and later became storekeeper at Port Huron and Saginaw, Mich. During the war he served as tie and timber agent for the Pere Marquette, Grand Trunk and the Ann Arbor.

William Garstang, who retired as general master car builder of the Cleveland, Cincinnati, Chicago & St. Louis and the Peoria & Eastern in December, 1913, and who for the past several years has represented the Gould Coupler Company at Indianapolis, Ind., died in Indianapolis on September 12. Mr. Garstang at the time of his retirement had been in active railway service for 50 years in the mechanical department and had been connected with the Master Car Builders' Association and the Master Mechanics' Association for about 35 years. In 1894 and 1895 he was president of the Master Mechanics' Association. He served on the committees that adopted the M. C. B. standard car axle, journal box, journal brass, journal wedge and standard wheels. He had also served for many years as chairman of the Committee on Standard Wheels. He designed and contracted for the Cleveland, Cincinnati, Chicago & St. Louis shops at Beech Grove, Ind., and the work was carried out under his supervision, in addition to his other duties. Mr. Garstang was born on February 28, 1851, in England, and was educated in the public schools. In 1862 he was a water carrier for the contractors on the laying of track from Fort Erie to Niagara and in December, 1863, entered railway service as a machinist apprentice at Cleveland, Ohio, where he remained six years, on the Cleveland & Erie, which later became part of the Lake Shore & Michigan Southern. During this time he went to night school and studied mathematics and mechanical drawing. He subsequently served consecutively for 11 years as machinist and general foreman of the Atlantic & Great Western and the New York, Pennsylvania & Ohio; for three years as general foreman of the Cleveland & Pittsburgh division of the Pennsylvania; for five years as master mechanic of the Cleveland, Columbus, Cincinnati & Indianapolis, which later became the Cleveland, Cincinnati, Chicago & St. Louis; and in 1888 he was appointed superintendent of motive power of the Chesapeake & Ohio. On April, 1893, he was appointed superintendent of motive power of the Cleveland, Cincinnati, Chicago & St. Louis, remaining in that position until February, 1913, when he was relieved of a portion of his duties and served mainly in an advisory capacity, with the title of general master car builder, until his retirement in the following December. During his long railway service he had been closely identified with the progress made in railroading. His constant desire for additional knowledge and his aggressive activities in his chosen field of endeavor tended to keep him active and young in spirit.

W. Garstang